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1880	contained	25	different	adv'ts.	1887	contained	154	different	adv'ts.
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1882	"	45	"	"	1889	"	234	"	"
1883	"	63	"	"	1890	"	289	"	"
1884	"	82	"	"	1891	"	325	"	"
1885	"	100	"	"	1892	"	316	"	"
1886	"	138	"	"	1893	"	317	"	"

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STREET RAILWAY TRACTION PRIZE.

A bill introduced by Senator Coggeshall was passed at the last session of the New York State Legislature offering a prize of $50,000 for the invention of an economical street railway system of traction. We have thus far been unable to secure details, but it is probable that the bill incorporates the terms of the recent sham competition of the Metropolitan Traction Company.

A NEW SYSTEM OF POLYPHASED DISTRIBUTION.

Elsewhere Lieutenant Patten describes a new system of polyphased distribution which is interesting not only intrinsically but as showing the flexibility of alternating currents. As explained, the system is one in which two alternating currents differing in phase by 120 degrees are transformed at the generating station into triphased currents for line transmission by means of transformers, and at the point of consumption are again converted as required by the same means, step-up and step-down transformers being respectively used for the two operations. The salient feature claimed for the system, and the one in which it differs from that of Mr. C. F. Scott, which we recently described, is that either biphased or triphased currents may be transformed to a single alternating current that will tax the two biphased or three triphased lines equally, and thus secure an equal distribution of a single-phased load among the different circuits of a biphased or triphased system. As will be seen, the biphased currents are not generated in quadrature relation to each other, as in Mr. Scott's system, but with a phase difference of 120 degrees. Either ring type or simple transformers are used, according to the requirements, and thus a number of transformations rendered possible.

ELECTRICITY VS. COMPRESSED AIR.

In another column is printed an abstract from the annual report of the city engineer of Omaha, giving estimates for transmitting a large amount of power a distance of seven miles, and based upon both electricity and compressed air as the agents. While such a short distance is favorable to the use of compressed air, we doubt if it would actually have the advantage shown. The estimate for electricity is based upon prices which, owing to the already large experience in this country in building large units, and the simplicity of the estimates for the line, are probably very nearly correct. Those for compressed air, on the other hand, can only be approximate for lack of such experience, and, unless this one instance should prove an exception to similar doubtful estimates, would probably be far below the actual cost. The comparison between the advantages of electricity and compressed air is also hardly fair. The objection to electricity on the ground of less safety we are rather surprised to meet at this day, for it has become generally recognized that with the ordinary precautions now taken this has ceased to be an element to be considered. We are still more surprised to find that electricity as a mode of transmission for general power purposes is objectionable on the ground of relatively less ease of application, and that it affords less constancy of operation and freedom from jerks than power from compressed air. As the points named are the only ones urged in favor of compressed air and the points in which electricity is acknowledged to be superior are real ones and of great weight, the comparison is, in fact, entirely favorable to the latter.

RAPID TRANSIT.

While the force of public opinion caused the New York Legislature to finally pass a rapid transit bill for New York, the politicians and the interests adversely affected by it were sufficient to badly cripple the measure. If signed by the Governor the referendum clause requires that the matter be submitted to a vote, which also introduces a question of constitutionality, so that if the gauntlet is finally passed, work cannot be begun for a year or more. With the commission named in the bill, however, there is little danger of the Manhattan monopoly obtaining control as it did of the present commission, and there seems also to be no doubt as to the people approving the measure by their votes. Unsatisfactory as the position of New York is, it is yet better off than Boston, where there seems to be irreconcilable differences of opinion as to the proper rapid transit plan to adopt. While Mayor Mathews favors a subway plan, the rapid transit committee of the Legislature opposes it and favors elevated railways, and, as was the case in New York, the underground tunnel plan does not seem to have enough "in it" to gather much of a following. Chicago also appears to be committed to elevated railways, whose popularity everywhere may probably be explained on the ground that their construction involves many political berths and jobs through the condemnation of property and otherwise—for no rational grounds seem to exist for the preference.

PRACTICAL ASPECTS OF RESONANCE.

The subject of electrical resonance, though only recently brought forward in a definite shape by Drs. Pupin and Duncan, seems likely to play an important part in practical electrical engineering. In another column we publish the first part of an important paper by Mr. F. W. Dunbar, which shows that the principle of electrical resonance may possibly create a revolution in the electrical transmission of power. While the mathematical sections may appear difficult to some of our readers, they can nevertheless easily follow the article, as these sections are merely proofs of the statements made and do not therefore interfere with an understanding of the principles treated. As stated by the author, the object of the articles is to bring forward the practical importance of capacity and self-induction in long lines and demonstrate that, instead of being detrimental, they may, in a properly designed circuit, become of great practical utility and allow a great reduction of copper to be made over that of a direct current at the same voltage. It will also be shown that if the transmission line is in resonance the impedance of the receiving apparatus will not affect it, provided the line is over a certain length, which, fortunately, falls within practical limits. One point of great practical importance, however, is left open, and that is how the necessary self-induction may be obtained. The use of properly designed bimetallic conductors suggests itself, but then the question of losses through hysteresis comes in, as does the question of resistance if open coils are employed. These, however, are points that can be taken up in turn, and the principle of practically tuning long-distance electrical lines once established, a satisfactory solution for them will doubtless be found.

MODERN ELECTRICITY.

The development of alternating currents has, it may truly be said, revolutionized the science of electricity, and introduced an order of ideas much more complex and difficult to grasp than those connected with continuous currents. The latter require no particular preparatory education of the mind to understand, the ideas being of a simple kind that merely require an exercise of the ordinary faculties to comprehend. With alternating currents, however, the more abstruse notion of rates is introduced, which is one that everyday operations do not usually involve, and therefore has to be cultivated. The phenomena, therefore, due to the principle of rates cannot be thoroughly grasped until that principle is comprehended. As a consequence, whoever wishes to obtain a thorough understanding of alternating current phenomena must not depend too much upon his knowledge of continuous currents, but should rather commence again at the beginning and learn the fundamental principles, without which he cannot go very far. Ordinarily, our ideas are bound up in the absolute magnitudes of a phenomenon and with no reference to the influence of the rate of change of these magnitudes, but in alternating currents it is the rate of change which is the prime principle to be borne in mind, the nature of the phenomena, and, to a more or less extent, their effect, depending upon this alone. An extensive mathematical knowledge, however, is not necessary to understand the subject; in fact, the difficulty of treating it mathematically, except with the aid of assumptions that all depart more or less from the truth, are such as to be apt to render that method the last one to be chosen. On the other hand, some of the graphical methods proposed are even worse, as they introduce a complexity of lines, which, divorced as they are from any physical meaning, only further involves the subject. There are methods, fortunately, by means of which the path may be made clear for the student. That followed by Mr. Scott in his paper, recently reprinted in our columns, is one of these, as are those employed by Lieutenant Patten in his series of "Laboratory Notes." Neither of these uses any mathematics, the graphical representations are simple, yet the purpose sought is nevertheless attained. The use of analogies is another fruitful method. Dr. Pupin, in his explanation of the phenomena of resonance, has shown how beautifully this method may be employed, and it is the one used by Mr. Dunbar in another column with much success.

Students' Course at Schenectady.

An article in a recent issue of The Electrical World on the education of electrical engineers referred to the students' course in practical electrical engineering at the Schenectady works of the General Electric Company, but incorrectly stated that a fee of $100 is required for admission to the course. For a while, we learn, such a fee was charged, but it was soon found that it barred out many young men who had made their own way through college and were just the kind of men wanted, but who could not very well afford to pay an entrance fee; it was therefore abandoned and the money refunded to those who had paid. We are also informed that it is not the custom to put students at work sweeping floors and doing general dirty work, but, on the contrary, they are placed where they may learn the details of the various apparatus in the most systematic and thorough manner, the object being to supplement the collegiate education of the young men by a practical course that will render them thoroughly competent electricians.

The course is intended for a limited number of young men possessing the degree of civil, mechanical or electrical engineer, or who have had three years' experience in electrical or machine shop work. At present, we learn, the complement is full, and there will be no vacancies during the present year. The object is to furnish the student with a thorough practical knowledge of the various processes through which a piece of electrical apparatus is carried from its inception to completion, as well as of the various mechanical and electrical principles involved. To accomplish this the student is placed for a limited time in each of the various departments of the factories, where, under the supervision of the foreman, he takes part in the actual work done, and is given such instructions as may be necessary to enable

him to accomplish the work in an intelligent and satisfactory manner.

The usual time occupied in covering this ground is about two years, and the student is paid at the rate of 8 cents, 10 cents, 12 cents, and 17 1-2 cents per hour for each period of six months. All students are required to observe the same rules, regulations and hours of work as the regular workmen. The General Electric Company does not guarantee to retain in its employ any student after the completion of the prescribed course, and unsatisfactory work or a serious violation of the rules and regulations is considered sufficient cause for discharge.

The following is a schedule of the course, with the time devoted to each branch:

Kind of work.	Months.
1. Erecting Department:	
Assembling motors and dynamos	2
Winding field magnets	1
2. Tube Department:	
Galvanometer work, junction boxes, etc.	2
3. Armature Department:	
Winding and connecting armatures, Gramme ring	1
Winding and connecting armatures, drum	1
Testing armatures	1
4. Motor Department:	
Testing small motors and generators	2
5. Testing Department:	
Testing large motors and generators	2
Use of instruments and general testing	1
6. F. and A. Department:	
General machine work	2
Commutator work	1
Shop wiring and power station	2
7. Cable Department:	
Finishing cables, testing insulation, etc.	2
8. Engineering and special work	4
	24

American Institute of Electrical Engineers.

The Philadelphia local committee is making elaborate arrangements for the entertainment of members of the Institute who attend the coming annual and general meetings in that city. The social features are being especially arranged with regard to the attendance of ladies, and it is hoped that the fair sex will be well represented. This being the tenth anniversary of the Institute, the rule of strict attention to business will necessarily be relaxed somewhat in order that members and guests may avail themselves of the proverbial hospitality of the City of Brotherly Love. In addition to the list of papers published last week, Dr. Louis Bell will present one upon "Some Facts about Polyphase Motors."

A brief outline of the preparations in progress, prepared by Chairman Willyoung, of the local committee, embraces the following functions:

On Tuesday, May 15, address of welcome by Mayor Stuart, to be followed by the annual business meeting and reading of papers. Mr. Wurts' paper on "Lighting Arresters," will be accompanied by experimental demonstrations at the station of the Philadelphia Traction Company. In the evening will occur the annual dinner of the Institute and a theatre party for the ladies.

Wednesday afternoon, a tally-ho excursion will be provided for the ladies, and the Engineers' Club will tender a reception in the evening.

Thursday afternoon will be occupied by a visit to Cramps' shipyard, followed by a steamer trip down the river to Gloucester, where a shad dinner will be served.

Fuller details of the arrangements will be given in the official programme. Visiting members will be welcome to the office facilities of Messrs. Houston and Kennelly, rooms 1105-1106 Betz Building, near the Pennsylvania R.R. station, where letters may be addressed.

The secretary of the Institute would deem it a favor if those who propose attending the meeting will write him to that effect at 12 West 31st street, New York City.

THE CHICAGO MEETING.

The April meeting of the Chicago section of the Institute was held on the evening of April 25, and was a very successful one. A considerable number of electrical and street railway men not members of the Institute were present, the total attendance being over sixty. Mr. Rodman was chosen chairman of the meeting, and after the reading of Mr. Farnham's paper by Mr. Abbott and the exhibition of the lantern slides, the discussion was carried on by Messrs. Arnold, Abbott, Stine, Welles, Armstrong, Alderman Mann and others.

After the discussion was closed, it was moved and carried "that it is the opinion of the Western members of the American Institute of Electrical Engineers that the expenses incurred in connection with the local meetings held in Chicago should be paid out of the general fund of the Institute, and that a committee of three, of which Mr. Hibbard shall be chairman, be appointed to bring this matter to the attention of the Institute at the annual meeting in Philadelphia next month for the purpose of securing, if possible, such legislation as will make the general funds available for this purpose."

Power Transmission for Omaha.

In his annual report for 1893 Mr. Andrew Rosewater, city engineer of Omaha, discusses the problem of making Omaha a manufacturing centre by means of water power generated seven miles distant from the city and transmitted thereto by electricity or compressed air.

Two plans for the development of the water power have been studied, one based upon a continuous delivery for 24 hours, and the other on a delivery for 10 hours and a storage of the flow during the remaining 14 hours. The former would develop 18,567 h. p. throughout 24 hours at the wheel shaft at a cost of $2,000,000 for development, and the latter 22,279 h. p. for 10 hours at a cost of $1,500,000 for development, or, assuming 6,500 h. p. used in the first case during the night, at a cost for development of $80 and $67.33 per horse power, respectively. The cost of a net water power per annum at the wheel shaft will in the first case be $9.60 and in the second $8.08, calculated on the basis of 5 per cent. for interest, 4 per cent. for depreciation and repairs, 2 per cent. for operation and 1 per cent. for taxes.

Electrical Transmission.—An electrical installation capable of transmitting the requisite power a distance of seven miles with an efficiency of 70 per cent., based upon the prices given by electrical manufacturers, will cost about $73 per horse power of net delivery seven miles from the plant, and the yearly cost of transmission per horse power of a 20,000-h. p. plant is estimated as follows:

Interest, 5 per cent.; depreciation and repairs, 8 per cent.; attendance and operation, 2 per cent.; taxes and insurance, 1½ per cent.; total, 16½ per cent.; 16½ per cent. of $73.00 equals	$12.05
Estimated cost of canal power, $9.60, which to deliver one electrical horse power net must be: $\frac{100}{70}$ of $9.60, equals	13.71
Total cost per net horse power, plan No. 1	$25.76
With canal at $8.08 per horse power at wheel shaft; $8.08 multiplied by $\frac{100}{70}$ equals	$11.54
Electric transmission per horse power	12.05
Total cost per net horse power, plan No. 2	$23.59

Compressed Air.—The cost per net horse power of compressors, receivers and seven miles of mains for a 20,000-h. p. installation, based on 70 per cent. efficiency, per net horse power, delivered, is estimated at $52.70. The annual cost of transmission is approximated as follows: Interest, 5 per cent.; depreciation and repairs, 6 per cent.; attendance and operation, 2 per cent.; taxes and insurance, 1 1-2 per cent.; total, 14 1-2 per cent., which gives $7.64 as the annual cost of transmission per net horse power.

Cost of canal power required to develop one net power delivered (plan No. 1)	$13.71
Cost of transmission	7.64
Cost of coal for reheating	.80
Total	$22.15
Canal horse power per (plan No. 2)	$11.54
Cost of transmission	7.64
Cost of coal for reheating	.80
Total	$19.98

The above includes the cost of coal for reheating at point of consumption to compensate for loss in transmission.

Mr. Rosewater is of the opinion that there are advantages in compressed air transmission over electrical transmission, due to the mechanism being much simpler, the absence of danger in connection with its use, its direct applicability to old engines and more extended application. In addition, he states that the lost power of transmission can be regained with the application of very little heat where the power is used, it being claimed that over 70 per cent. of the heating power of coal can be derived in heating compressed air, while less than 15 per cent. is obtained in its application to the steam engine.

Mr. Rosewater gives the following estimated cost of 1 h. p. generated by steam in the vicinity of Omaha, January, 1894:

Description of Plant.	Net Horse Power.	Tons of 2,000 lbs. slack consumed per hour.	Cost of slack per h. p. per year of 308 days, 10 hours each, at $1 65 per ton.	Approx. cost of engineer, fireman, supplies and repairs per h. p. per year of 308 days.	Approx. cost of ins., int., tax and depreciation per h. p. per annum.	Approximate total cost per h. p. per annum.
Omaha Street Railway	1,500	5.71	$19.34	$6.00	$6.33	$31.67
*Florence Station Omaha Water Works	911	1.583	8.83	6.00	6.33	21.16
Izard St. Sta. Omaha W. Wks	266	0.91	17.40	7.85	7.77	33.02
B'way Sta. Co. Bluffs. "	215	0.83	19.62	8.92	8.01	36.55
Walnut Hill Sta. Omaha "	122	0.33	13.72	15.15	8.77	37.64
Woodman's Lins'd Oil Wrks.	100	0.50	25.41	15.15	8.77	49.33
Co. Bluffs Bridge & Motor Co	100	0.435	23.12	15.15	8.77	47.04
20th and Popple'n Sta. Omaha Water Works	66	0.409	31.49	25.87	10.39	67.75
River Sta. Co. Bluffs W. Wks.	63	0.60	48.40	25.87	10.39	84.66
Lincoln Street Railway	425	....	22.76	9.65	7.10	39.51
Phoenix Foundry, Omaha	50	....	....	....	....	....

The cost of coal was deduced from approximate data obtained at the various installations mentioned. The remaining expenses were approximately deduced from statements and tables of steam engineering experts.

* Triple expansion engines.

For comparison with the above we give below a carefully prepared schedule by Dr. Emery, which Mr. Rosewater finds closely approximates to data he gathered from various sources, the cost being expressed per year of 308 days of ten hours each:

5 horse power engines	$175.00	per horse power
10 "	108.75	"
15 "	88.80	"
20 "	72.10	"
25 "	66.00	"
50 "	51.00	"
200 "	27.50	"
300 "	25.80	"
400 "	25.01	"
500 "	24.70	"

The following is a resume, showing the comparative total investment in steam and water power plants as per plans 1 and 2, and the cost of operation per annum, the latter including interest, maintenance, etc.:

		Electrical transmission. Cost of plant.	Electrical transmission. Annual expense.	Pneumatic transmission. Cost of plant.	Pneumatic transmission. Annual expense.	
1	Steam	$1,977,266	$680,459	$1,719,243	633,178	Net horse power
	Canal	2,916,081	342 378	2,703,308	$295,098	delivered, 13,097.
2	Steam	2,409,403	704,542	2.086,667	647,126	Net horse power
	Canal	2,660,408	374,986	2,337,719	317,603	delivered, 15,896

The following resume shows the relative cost per net horse power delivered in the city by steam and water transmitted electrically and by compressed air on schemes 1 and 2:

*Scheme 1, steam power electrically per net horse power per year of 300 days of ten hours each	$44.32
*Scheme 1, steam by compressed air per net horse power per year of 308 days of ten hours each	40.71
Canal power, 24 hours continuous delivery, electrically as above, scheme 1	25.76
Canal power, 24 hours continuous delivery, by compressed air as above, scheme 1	22.15
Canal power, 24 hours continuous delivery, electrically as above, scheme 2	23.59
Canal power, 24 hours continuous delivery, by compressed air as above, scheme 2	19.98

*Twenty-five per cent. to be added to make up for 6,500 h. p. night service on water plant.

The conclusions reached by Mr. Rosewater are as follows:

First—There is over 50 per cent. loss sustained in the operation of power plants as generally used.

Second—This power can be more economically secured through large central power installations.

Third—That with the existing conditions at Omaha, water power is cheaper than steam power.

Fourth—As between electricity and compressed air as a mode of transmission, for lighting and electric railway purposes, an electrical installation of sufficient capacity directly connected with the waterwheel will be preferable. For general power purposes, on the grounds of greater safety and ease of application, constancy of operation and freedom from jerks, which are complained of even where large flywheels in electric transmission are used, compressed air would be more desirable and economical.

Thirteenth Annual Meeting of the American Street Railway Association.

The thirteenth annual meeting of the American Street Railway Association will be held at Atlanta, Ga., on Oct. 17, 18 and 19, 1894. The following papers and addresses will be presented:

"Can the T Rail be Satisfactorily Used in Paved Streets?" Joel Hurt, president of the Atlanta Consolidated Street Railway Company, Atlanta, Ga.; S. Hendrie, manager of the Wyandotte and Detroit River Railway Company, Detroit, Mich., and H. J. Crowley, engineer of the Atlanta Consolidated Street Railway Company, Atlanta, Ga.

"City and Suburban Electric Railways": Elwin C. Foster, superintendent of the Lynn and Boston Railroad, Boston, Mass.

"Mail, Express and Freight Service on Street Railway Cars": Richard McCulloch, electrical engineer of the Citizens' Railway Company, St. Louis, Mo.

"The Best Method of Treating Accidents and Complaints": John B. Parsons, general manager of the West Chicago Street Railroad, Chicago, Ill.

"Street Car Wheels and Axles": D. S. Cook, electrical engineer of the Trenton Passenger Railway Company, Trenton, N. J.

"Transfers and Commutation": Rodney Curtis, president of the Denver Tramway Company, Denver, Col.

"The T Rail Construction of the Terre Haute Street Railway Company": M. F. Burke, superintendent of the Terre Haute Street Railway.

"A Standard Form for Accounts for Street Railways": H. I. Bettis, constructing engineer of the Atlanta Consolidated Street Railway Company, Atlanta, Ga.

Testing Iron.

In the Lond. "Elec.," April 13, Mr. Parsons gives some further information regarding the matter mentioned in the Digest April 14, and under "Hysteresis Testing," April 7; he ascertains that the induction is equal in both cores by observing whether the voltage across the terminals of each coil is the same; in iron cores of medium permeability, practically the whole magnetic resistance lies in the air gap, hence with similar cores of iron the induction is necessarily equal; since the total number of lines, if the coil has a small resistance, is proportional to the voltage of the coil, by varying the cross-section of the core, the induction can be varied; that this is correct, he claims, is shown by the rate of increase of temperature varying with the cross-section of the core.

Direct Currents "Not Quite Obsolete."

In a recent discussion in a London electrical society, Mr. Mordey, in referring to a certain instrument, remarked that it "was only suitable for direct currents which were not quite obsolete."

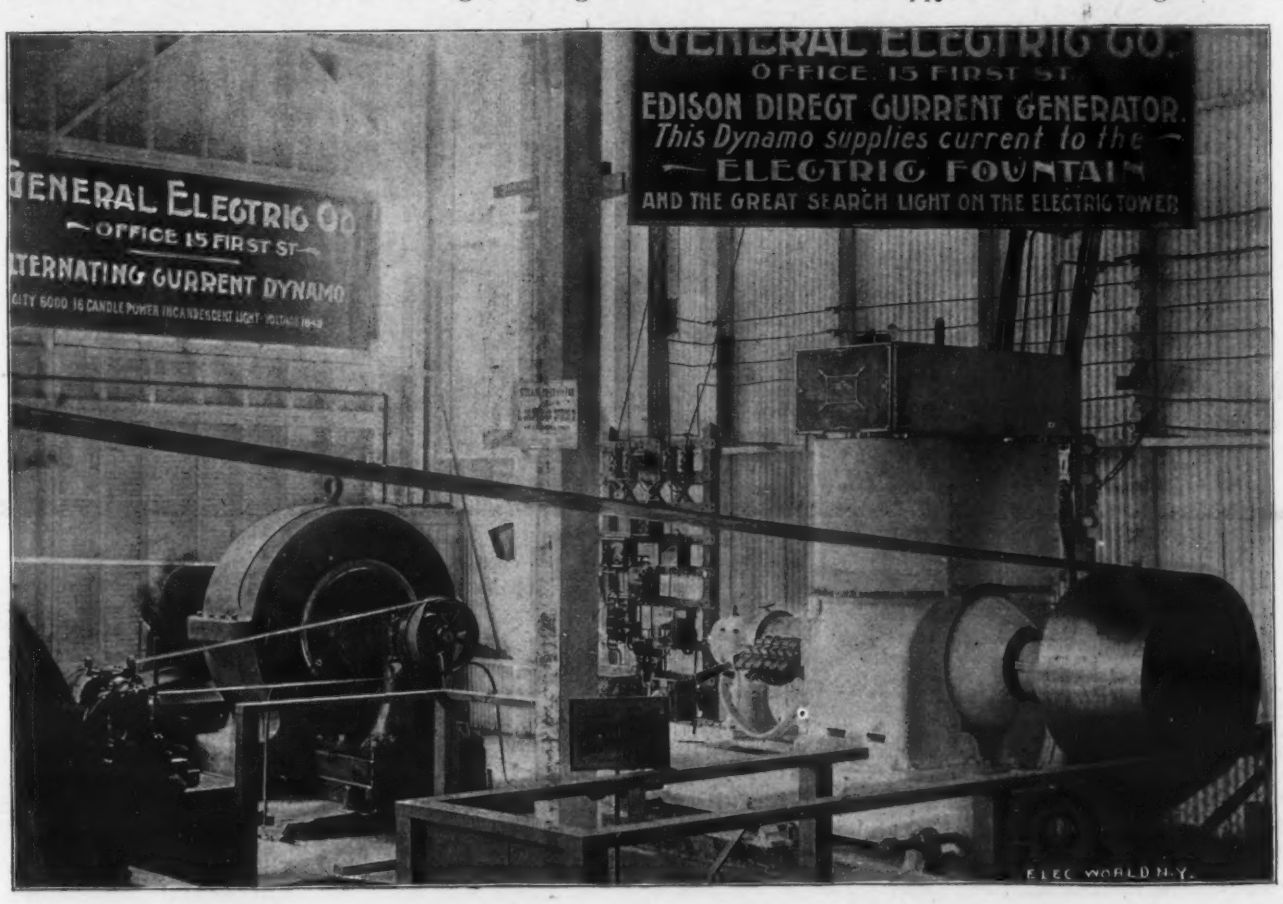
ELECTRICAL FEATURES OF THE MIDWINTER FAIR.

No industrial exhibition in these days would be considered successful in which a considerable portion of the space allotted to machinery was not taken up with electrical machines and apparatus. The Midwinter Fair, though far from the industrial centres, has a fine electrical exhibit, almost entirely from beyond the Mississippi, and the fact that the Eastern manufacturers are willing to incur the expense incident to an extensive display shows the important position the extreme West is taking as a user of electrical machinery.

The Pacific coast early took a position in the electric railway field, and now has many fine roads in operation and many more projected or building, while recent schemes for long distance transmission of power on a large scale make the coast well worthy of study.

As was the case at the World's Fair at Chicago, the largest exhibitor is the General Electric Company, about half the available space being taken up by it. Its exhibit covers very well every variety of commercial apparatus made at its factories, a very prominent place in the centre of the hall being given to the multiphase and mining display. Incandescent lighting is so well known and needs so little advertising, that only visitors with a capacity for nosing about, or with a love for machinery, will be likely to find the exhibit of incandescent apparatus. It is not by any means insignificant, but is placed in the annex, outside the regular beat of visitors. Nevertheless it is prominently placed in the annex, and the machines are of sufficient capacity to attract attention. The view given shows that it consists of machines of both the direct and alternating current type. The alternating system is represented by one 6,000-light Thomson-Houston alternator of 24 poles and giving 1,040 volts at 680 revolutions. It is belted through a counter shaft to a Corliss engine, hastily put together for the purpose. A standard skeleton switchboard carries the regular station instruments. This dynamo is used for lighting concessions.

The direct current is generated by a 150-kw. bipolar dynamo of the Edison type, shown on the right. It is run at


GENERAL ELECTRIC CO
OFFICE 15 FIRST ST
ALTERNATING CURRENT DYNAMO
OFFICE. 15 FIRST ST
EDISON DIRECT CURRENT GENERATOR.
This Dynamo supplies current to the
ELECTRIC FOUNTAIN
AND THE GREAT SEARCH LIGHT ON THE ELECTRIC TOWER
ELEC WORLD N.Y.

DISPLAY OF THE GENERAL ELECTRIC INCANDESCENT SYSTEM.

110 volts, and supplies current for the electric fountain, for the great searchlight on the Bonet tower, and a smaller one on Machinery Hall.

The series arc exhibit consists of eight Thomson-Houston arc dynamos of 50 lights each, together with the necessary lamps, etc. They are used for lighting roads and concessions and are run at full capacity. These dynamos are ar-

ranged in two groups of four machines each, one group being run by a Buckeye engine, and the other by a Russell. In each case a counter shaft is used to give the requisite speed, and two dynamos are driven from each pulley on the counter shaft.

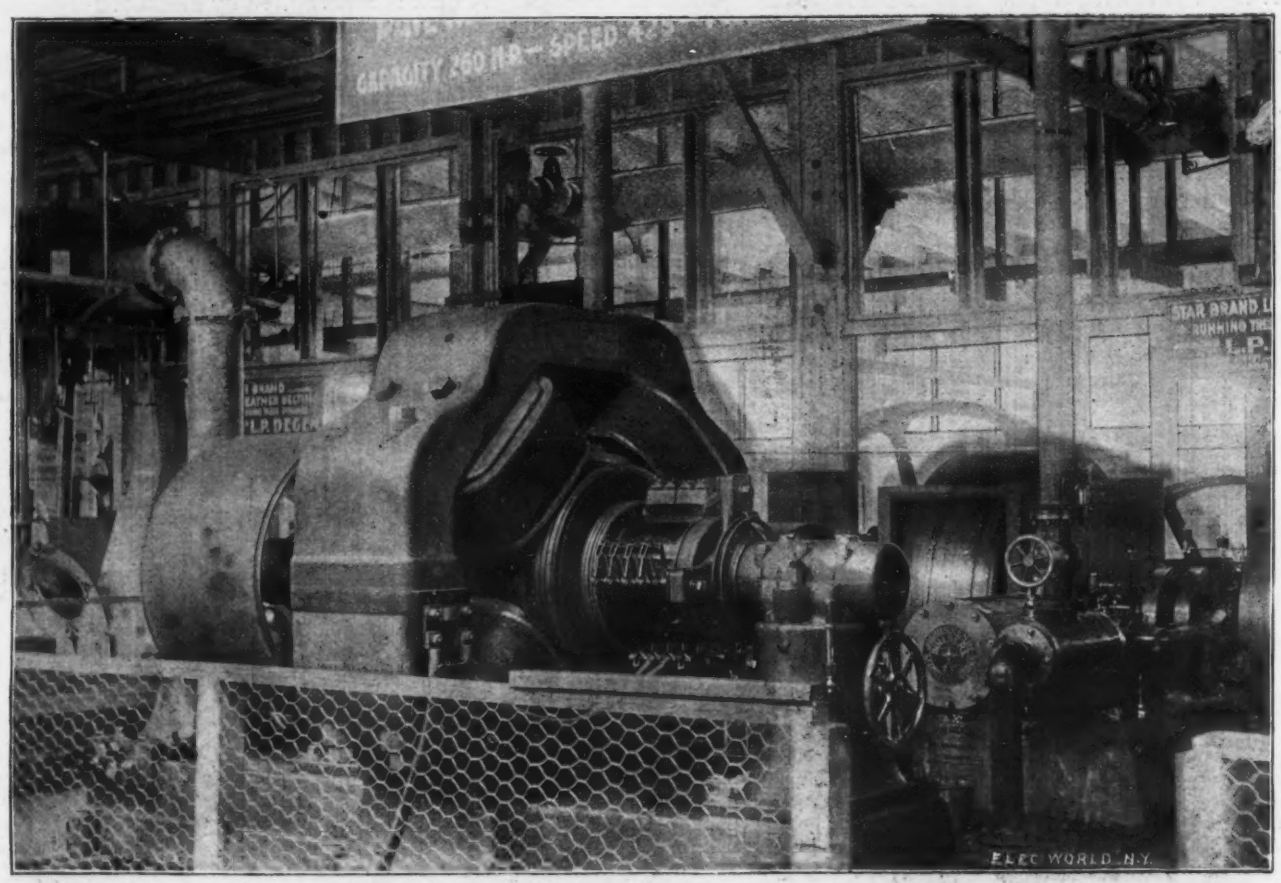
Railway station equipments are represented by one 200-kw. four pole generator, a view of which is given. It is used for lighting the cornice lamps on the main buildings, furnishing current for the elevator motor in the tower, running a 60-kw. motor for the Western Electric Company, and several small motors in the Manufacturers' Building and other parts of the grounds. The cornice lights are arranged in groups of ten in parallel, with five groups in series, single series of five lamps being used where necessary to fill in a space. There is also a panel with necessary power house instruments.

The railway exhibit is limited to a truck fitted with two G. E. 80c motors, with S. P. controllers. The motors turn slowly with a 110-volt current, the truck being raised to allow the wheels to revolve.

Two views are given of the multiphase and mining exhibit, which occupies a prominent place in the centre of the hall, just in front of the main entrance. The company has been at considerable pains to make this exhibit as attractive as its prominent position warrants, and it certainly is not the least interesting display, even to those who look and wonder what it is all about.

The generating station of the multiphased system consists of a 15-kw., 500-volt bipolar motor, of the Edison type, which runs a 35-kw. triphased generator, giving a current at 300 volts. A skeleton switchboard, with all necessary instruments, passes the currents to step-up transformers, where the pressure is raised to 6,000 volts. A line about 40 feet long carries this current to a receiving and distributing station, where the pressure is reduced to 110 volts. On each of the three circuits are placed 20 lamps, and on two of them are incandescent arcs, each with its regulating rheostat. Current is also supplied to run a 10-h. p. triphased induction motor, which is belted to a drill generator of the Thomson-Houston type, with revolving brushes. A 7 1-2-h. p. drill, of the Marvin type, is set up, and at times picks holes in a block of granite for the edification of a crowd, who wonder what it is for and what's the use of doing it. The granite block was placed on the main floor by the side of a booth in which is an oil display, and when the drill was at work it shook the floor so much as to knock over the oil exhibit. To avoid this it was necessary to make a special foundation for the block, thus insulating it from the floor. The drill is a somewhat modified form of the Marvin formerly made by the Edison company, and the report is that this type is to be used to the exclusion of the old Thomson-Houston form. A 5-h. p. triphased induction motor and a rotary transformer complete the multiphased exhibit.

There is a considerable display of mining machinery, the exhibit comprising a 10-h. p. sinking pump for deep mine work, 3-h. p. centrifugal pump outfit, a 3-h. p. motor runing a triplex pump, made by the Risdon Iron Works, of San Francisco; a portable pump and motor on truck, a 2-h. p.



200 KW. GENERAL ELECTRIC RAILWAY GENERATOR.

diamond prospecting core drill, capable of drilling 600 feet and taking out a 1 3-8-inch core; a hoist and the reciprocating drill previously mentioned. There is also a 20-h. p. mining locomotive of 24-inch gauge.

One of the views shows a neat display of switches, cut-outs, station instruments, etc., and several clusters of lamps on pole tops make a very effective incandescent display. Several Lundell fan motors, with gay streamer attachments, show at once the power of wind, and attract the attention of the girl with an eye to color effects in ribbons.

The great searchlight on the tower, the most powerful in the world, and emitting a light, the intensity of which is guessed to be hundreds of milions of candle power (the guess is 350,000,000 c. p.), is the exhibit which produces the most far-reaching effect. Under proper conditions as to atmosphere and elevation, this light can be seen 120 miles, and

when turned towards the city it spreads out in a broad, silvery cone, the effect of which is especially fine when seen from the hills on the north side of the city. As seen from this point, the light just grazes the crest of a hill, and the outline of the beam is very sharp against the dark background. The lamp takes 200 amperes at 90 volts; the lens is 60 inches in diameter, and the carbons two inches.

Mr. W. F. C. Hasson, the chief electrician of the fair, has made a novel proposition for determining the candle power of this lamp. He proposes to use a smaller lamp, the power of which can be measured, but which is sufficiently powerful to be seen in the instruments at Mount Hamilton observatory. Observations of the two beams would enable the relative intensities at the observatory to be determined, and consequently the candle power of the great lamp. The work would be placed in the hands of experienced comet finders.

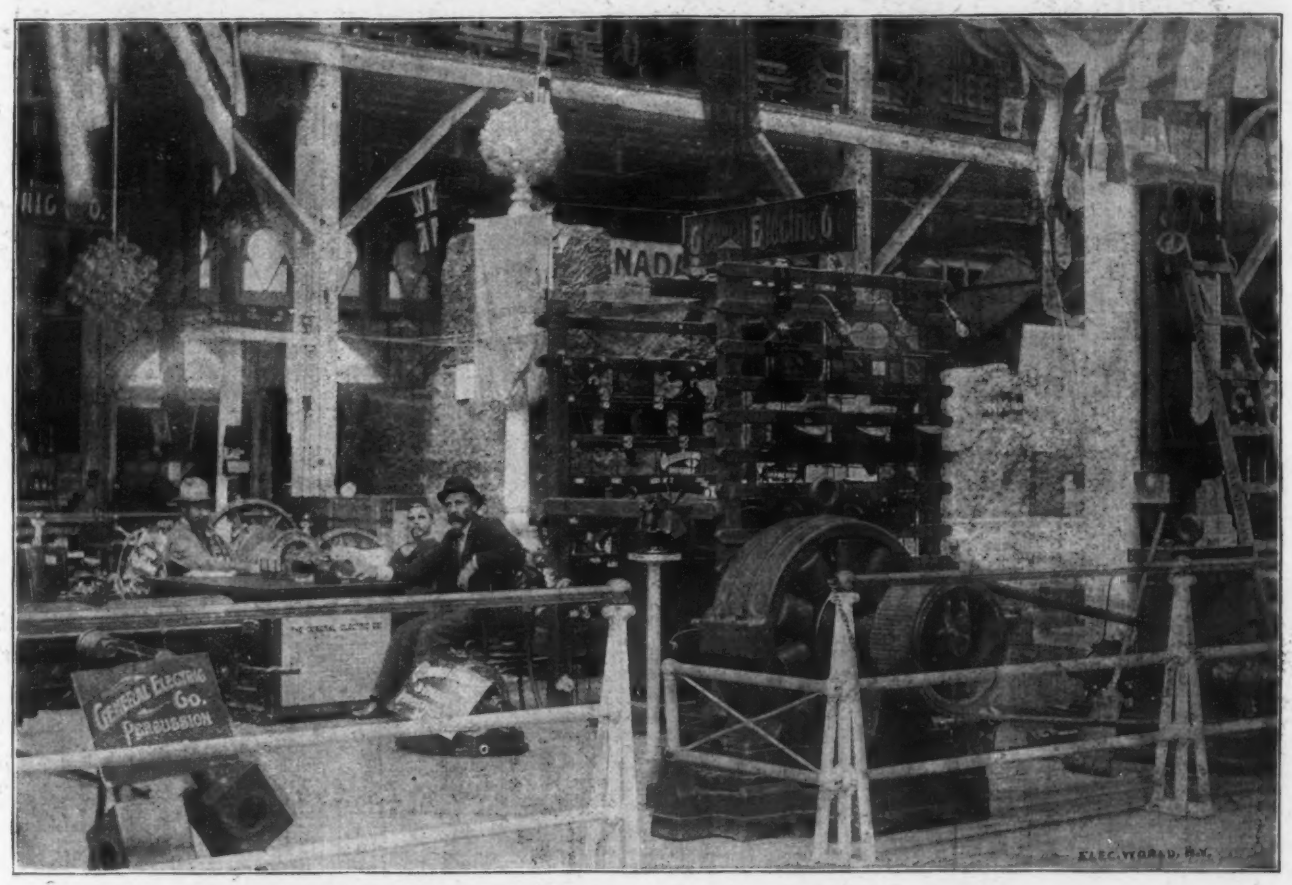
The first proposition of the General Electric Company was to furnish five railway generators, from which buildings, concessions, etc., could be lighted by lamps in series of five. These machines were tendered because they were such as could be sold on the coast, and would not require retransportation to the East. Large incandescent machines could not be sold here, and, as it was not at first considered that the fair would be of any real importance, the electrical companies would not consent to incur any expense for which they could not expect some return. When, however, one of the electric fountains in use at Chicago was finally purchased by the exposition, the General Electric Company became very liberal in its tender of machines, and made the installations, without which much would be lacking to make the electrical exhibit, and even the Midwinter Fair itself, a success.

The exhibit of the Western Electric Company is only less extensive, and not less attractive, than that of the General Electric Company. Indeed, its lighting of the Bonet tower is by far the most important and attractive display, except during the brief intervals when the electric fountain is playing, and the honor of making the fair an electrical success lies largely with these two companies.

The Western Electric Company's exhibit occupies a prominent place on the main aisle of Machinery Hall, and is well calculated to catch the eye. The largest machines shown are two 220-volt, 6-pole, 150-kw. generators, used for furnishing current for the town stationary lights, which are wired two in series. They are driven by a vertical compound engine, built by the Union Iron Works, of San Francisco, it being one of six intended for the Mission street electric road, which is now building. A view of the machines is given.

The portion of the exhibit which attracts most attention is a motor-generator combination, which runs all day. This consists of a 60-kw., 500-volt generator, which is connected up to run as a motor, taking current from the General Electric Company's 500-volt circuit. This machine was intended to be run as a generator and supply current to the elevator motor, and a power circuit in Manufacturers' Building and other places, but the engine available was too small, and as the General Electric Company had its large railway generator, arrangements were made by which it was to supply the power circuit and run the Western Electric Company's generator as a motor. The motor thus supplied runs two 30-kw. machines, on one bed, which were originally intended for a motor-generator combination, the motor taking current at 220 volts, and the generator giving 110 volts, but as now connected up both machines run as generators, the 220-volt converted motor supplying current to a power circuit that runs through the various buildings, and the 110-volt machine furnishing current for a scenic theatre, run by the Western Electric Company. This combination machine was on exhibition at Chicago, and was run as originally intended, i. e., as a 220-volt motor, driving a 110-volt generator. In addition to these machines, the company has several motors ranging from 1-2 to 20 h. p.

The switchboard is the only one in the fair in which anything elaborate has been attempted. It is the same that was



A CORNER IN THE MINING AND MULTIPHASED EXHIBIT.

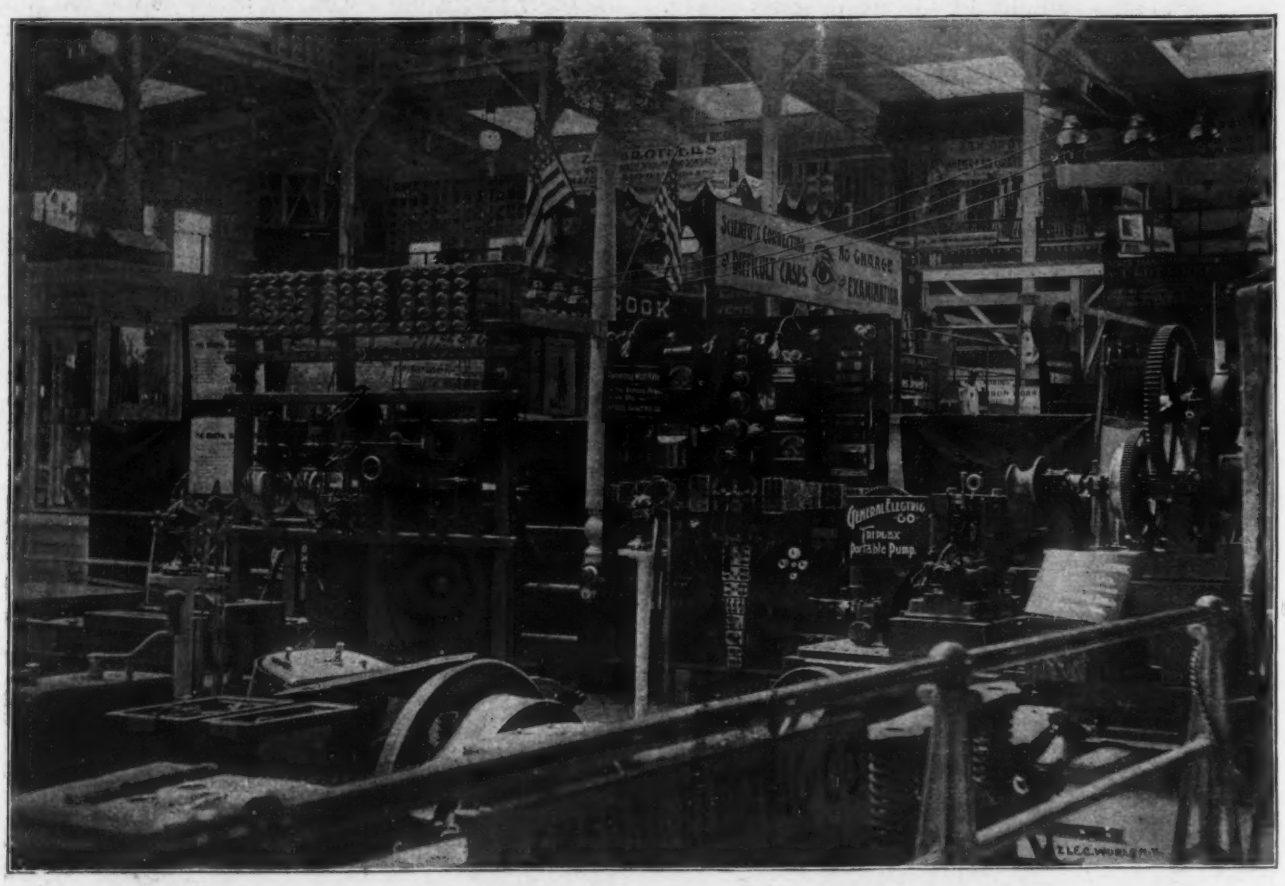
used at Chicago. The portion shown on the right of the view consists of seven panels, five of which are for arc lamps, the capacity being for 700 lamps; the sixth panel is fitted as a testing board, with ground alarm, etc., and the seventh is for a 220-volt direct current, the capacity being 1,200 amperes. Four 50-lamp arc machines are connected to this board, and are used for running 150 arc lamps of 2,000 c. p. in the Manufacturers' and Liberal Arts Building. They are of the regular Western Electric type, the armatures being wound in 12 sections with a 12-part commutator.

The distributing board shown on the left is made in six sections, five of which are for 110-volt circuits and the other for 220 volts. It carries on the back the field rheostats for the 30-kw., 110 and 220-volt generators, and the starting rheostat for the 500-volt motor. All the back connections are neatly made and exposed to view. All bus bars and connectors are calculated on the basis of 1,000 amperes per square inch of copper section, 600 amperes per square inch of brass section and 300 amperes per square inch of surface for surface contacts.

Both these boards are dark marble, highly polished back and front, and present a very neat appearance.

A small exhibit just outside the rail, which attracts considerable attention, is a small electromagnet, the keeper of which comes off with a pull of about 400 pounds. It is fitted with a handle large enough to be grasped with one hand only, and is generally surrounded by three or four men, who tug away, one after the other, and finally give it up. Then there appears that unique product of the Midwinter Fair, a gum girl, who seizes the handle, gives it a quick jerk sideways, and off it comes, while the strong men look silly. They then all do as she did, and go away satisfied, thinking how easy it is when you know how.

The company has on exhibition a pair of its new arc lamps for incandescent circuits. They are extremely simple and burn with a very steady light. There is only a shunt coil, the series coil usually employed to draw the arc being in this lamp replaced by a stiff, flat spring. The carbon rod is held by the clutch generally used in the Western Electric Company's arc lamps, this clutch being closed by the action of the stiff spring, which acts on the armature of the magnet in opposition to the shunt coil. When the lamp is not burning the main circuit is open, the carbon points being drawn apart by the action of the spring. When current is turned on its only path is through the shunt coil, which is consequently strongly energized, and its armature drawn down against the force of the spring, thus opening the clutch and releasing the rod, which drops and completes the circuit through the carbons. Instantly the shunt circuit loses its current, and the action of the spring opens the circuit and draws the arc. An auxiliary spiral spring is used for adjusting the balance between the main spring and the shunt magnet, so as to maintain the arc at the proper length. The feeding is by imperceptible degrees and the arc remains of almost constant length.

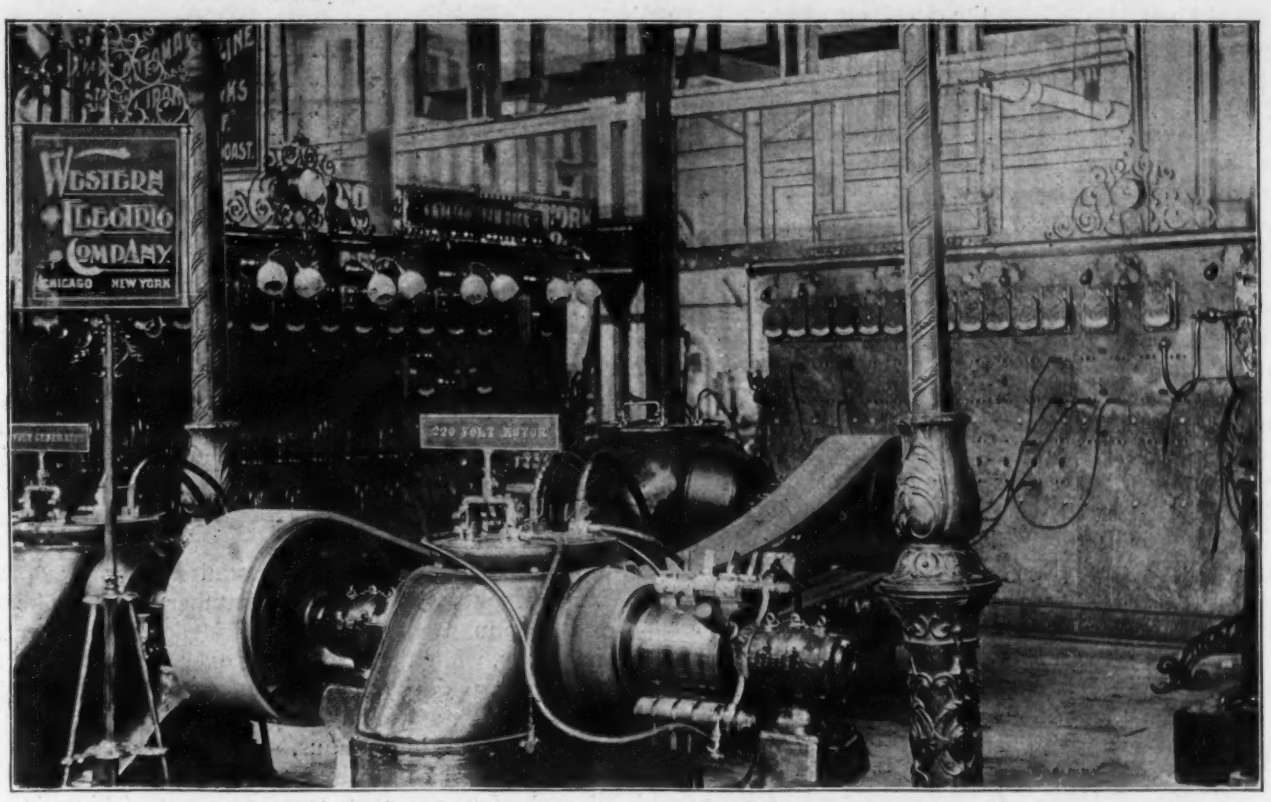


A VIEW OF THE MINING AND MULTIPHASED EXHIBIT.

A singular accident happened to one of the company's employes. He had tinsel braid on his coat sleeve, and one day was leaning his arm on the handle of a 220-volt double pole switch, when it slipped off and wedged between the two parts of the switch so that the braid on his sleeve short-circuited the mains, with the result that there was a fine display of fireworks and a man with a burned eye. That the braid on his sleeve was metallic and might be a source of danger had never occurred to him, and it was two days before he was really certain what had happened.

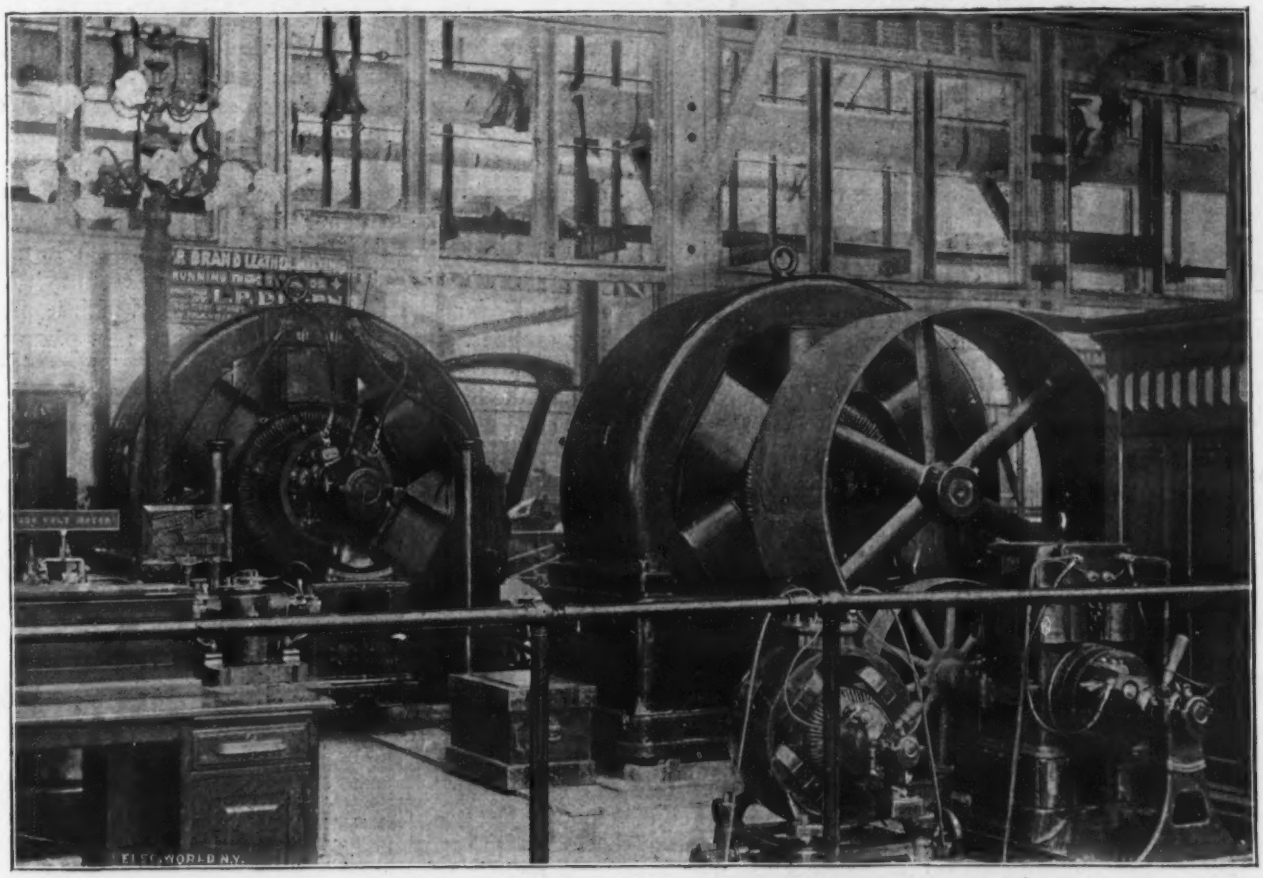
Among the most important exhibits of the Western Electric Company is the automatic revolving switch controlling the disappearing figures on the tower. This consists of a cylinder 85 inches long and 12 inches in diameter, made up of a large number of thin cast-iron discs set with 5-8 inch space between them. Each of the discs is furnished with holes and slots along the edge, through which bolts can be passed for securing pieces of hard wood, which project 3-4 inch above the surface. These pieces are 1-2

inch wide, and are curved and set concentric with the cylinder. They are of various lengths, depending upon the time



AN INTERESTING MOTOR-GENERATOR COMBINATION.

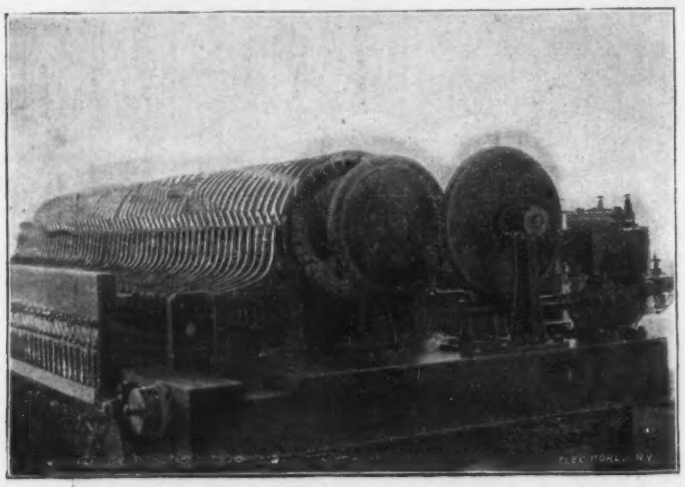
the circuit is to be closed. Two rods, the length of the cylinder, and placed one on each side, acts as centres, upon which swing 56 bell cranks of cast brass. One main from the dynamo is connected with these centres, thus making the bell cranks part of the electric circuit. The horizontal arms of these levers have holes formed by pieces of spring brass bent round and bolted to the ends of the arms, and in these holes are secured, by spring pressure, short pieces of arc light carbons, which can make contacts with corresponding pieces held in springs secured to circuit boards, one of which is placed on each side of the switch (the view shows one of them). The springs in which these second carbons are secured are quite stiff, so that the carbons can be pressed together with considerable force, and each spring is connected



WESTERN ELECTRIC 150 KW. GENERATOR.

with a binding post, by means of which it can be placed in a circuit leading to a group of lamps on the tower. Springs acting on the bell cranks keep the circuits broken at the carbon contacts, except at such times as they are pressed forward by the pieces on the revolving cylinder. The cylinder is turned steadily by a 1-2-h. p. motor, the speed of which is reduced by one spur and one worm gear. Usually the cylinder has a speed of about two revolutions per minute, but by means of a rheostat in the field of the motor, the speed can be varied from 2 to 13 revolutions.

The figures to be produced having been designed, the lamps composing it are wired in the groups as required, and circuits led to the circuit boards on the switch. The wooden pieces are secured to the cylinder so as to make the contacts in the order and for the time required. If the groups of a figure are to be lighted and extinguished one after the other at short intervals, a number of short pieces will be secured to the cylinder in a spiral fashion, so that one contact will be broken just as the other is closing. If it is desired to have the groups light one after the other and remain lighted until the figure is complete, the pieces on the cylinder will have a spiral beginning and all end on the same line, so that as the last group lights they will all break away and leave the figure with all lamps extinguished, ready for a new beginning, with contacts differently arranged, so as to produce several different figures with the same lamps. It will thus be seen that with a given number of lamps in a large group, but wired with several sub-groups, a number of



REVOLVING SWITCH CONTROLLING FIGURES ON THE TOWER.

different figures can be produced during a revolution of the cylinder.

This switch is arranged to control 12 figures on the tower, each of which consists of several sub-figures. As the cylinder revolves there comes a point where all the lamps of the figures are lighted, and a little further movement of the cylinder causes all contacts to break away, and the figures begin again. Fifty designs were made by Mr. Jenness, of the Western Electric Company, and of these 12 were chosen after a consultation between the company's representative and Chief Electrician W. F. C. Hasson.

The carbon contacts open about 1-2 inch, and with 110 volts the arcs would hold. To avoid this, a blower, run by a motor, placed beneath the switch, discharges air into a 2-inch pipe running the length of the switch and close to the carbon contacts. Short, flat nozzles end close to the contacts, one for each, and a continual blast of air plays upon them and blows out the arcs when the circuits are broken.

A similar switch was used by this company at Chicago, but it was sold to Mr. Wanamaker, of Philadelphia, for controlling lights in his store, and this one was specially made for this exposition. The view given shows it very clearly.

(To be continued.)

The Cost of Producing Electricity.

BY JAS. B. CAHOON.

AT the last meeting of the National Electric Light Association one of the most interesting reports made was that of the committee on data giving in tabulated form the reports of the watt-hours, pounds of coal, kinds of coal, watt-hours per pound of coal and various other data from 65 stations situated presumably in the various parts of the country. An analysis of this tabulated statement seems to show on the face of it that the central stations as a whole throughout the country are not in the habit of keeping this particular kind of data, and in many instances where the watt-hours per pound of coal runs low, it would indicate fitfulness in operation, combined with remarkably poor firing in the boiler. It seems hard to conceive that any station at the present time should require 20 pounds of coal per hour for each indicated horse power, yet we find three stations reporting practically what amounts to this; and the number requiring between 10 and 20 pounds of coal per indicated horse power is quite numerous, while those requiring over five pounds of coal are in a great majority. I find on averaging up the different kinds of coal, and combining most of them under the four heads of slack, bituminous, small hard and screenings, that 16 users of slack furnish an average of watt-hours per pound of coal of 72.75; next come 10 users of bituminous coal, which gives an average of 75.6; then 12 users of small hard, with an average of 116.4, while lastly two users of screenings head the list with 183 and 208 watt-hours respectively per pound of coal, while Youghiogheny coal, which is supposed to be at the head of the list of steaming coals, makes the unfavorable showing of 83 and 104 watt-hours from the two places reporting this. I think we would be perfectly justified in saying that if manufacturing concerns can, with their large Corliss engines and first-class boiler plants with suitable attendants, produce horse power at the rate of 1 h. p. for every 1 1-2 pounds of coal used, then our large and well equipped central stations in the largest cities should do equally as well, while those in the smaller sized cities and towns, where the load is more unequal, should at least obtain 1 h. p. for each 2 1-2 pounds of coal, and the stations in country towns running only for seven or eight hours a day, with non-condensing engines, should be able to produce 1 h. p. on approximately five pounds of coal per hour. These figures are within the bounds of reason, and warranted if we are to strive for economical results and a proper dividend on our investment. We, of course, expect that the stations in different parts of the country will use that coal which is nearest to them, provided it be the most economical as well. An average theoretical value of coal is given by various authorities in pounds of water evaporated as follows, from which it will be seen that the value is not as variable as many people suppose:

TABLE I.—THEORETICAL VALUE OF COAL.

Kind.	Lbs. of water evaporated.
Youghiogheny	14.76
Pennsylvania anthracite, average	14.48
Colorado lignite, average	14.20
Texas lignite	13.41
Illinois, average	13.35
Cumberland	12.65

Of course the practical value of these coals is considerably less than that shown; either, however, does to illustrate the point that no one section of the country need say that they cannot compete with another section, because they are handicapped too heavily in the steaming quality of their coal.

In going over the table of data it seems to me that a con-

venient way in which station men might find out the total watt-hours for their daily consumption of coal, as well as other points of interest, would be by the construction of a diagram similar to the one shown herewith; on this, the curve *A B C* is plotted from the number of pounds of coal per indicated horse power per hour as ordinates and watt-hours per pound of coal as abscissae, while the lines radiating from zero point are plotted with tons of coal as ordinates and total watt-hours as abscissae for each of the rates in watt-hours per pound of coal, running from 3c to 400.

The use of the diagram may be illustrated as follows: Suppose we are burning coal at the rate of two pounds per indicated horse power per hour and consuming 10 tons per day and we wish to find the total watt-hours. Start from the point 2 in the right-hand margin and go across horizontally until we meet the curve; thence proceeding vertically, we find on the upper margin the watt-hours per pound of coal to be 302.13, the nearest line to this is *O F* marked 300, following down the adjacent line corresponding to 3c2.13 until it intersects the horizontal line through 10 on the left-hand margin, we get vertically underneath the total watt hours as

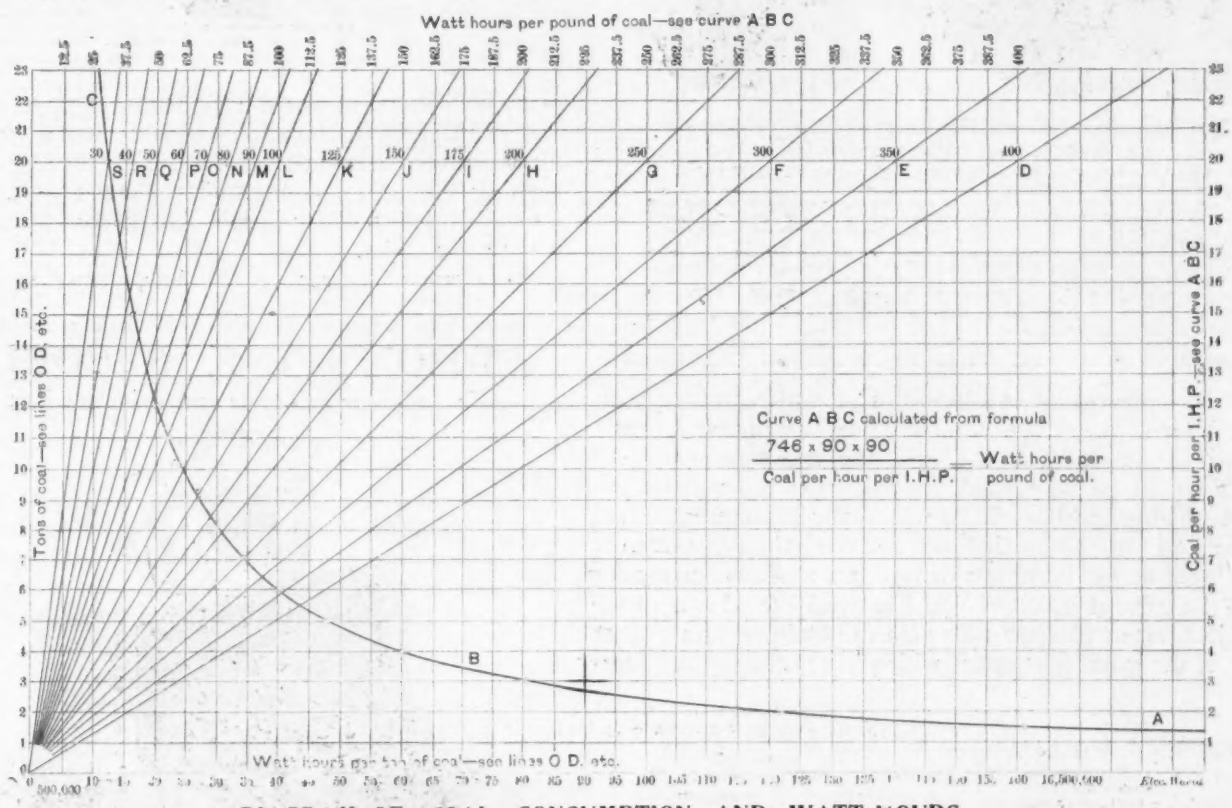


DIAGRAM OF COAL CONSUMPTION AND WATT-HOURS.

6,042,600. By starting with either of the other items indicated, any one of the others may be ascertained. This can easily be drawn out on quite a large scale, and will thus, I hope, prove of some assistance to station men.

(To be Continued.)

The New Wiring Installation of the St. Augustine (Fla.) Hotels.

The magnificent hotels, Ponce de Leon and Alcazar, at St. Augustine, Fla., have been recently rewired and refitted electrically in the most complete and approved manner. The original wiring was, at the time when installed, in accordance with current practice, but the underwriters condemned the work a year ago, and it has been entirely overhauled and a system installed by Mr. H. E. Best, the electrician of these hotels, which is not only up to all requirements, but ahead of them. The cabinet system of cut-outs is exclusively used, the cabinets being made entirely of polished marble. Each circuit (having five lights on the average) is controlled by a single-pole porcelain knob switch. The feed wires are connected to each cabinet by a double-pole knife switch of the old Edison pattern and protected by fuses. The main switch connects with the balance wires, which join the ends of all feeders, each connection to balance wires being through a double-pole knife switch with fuse cut-out. Each cabinet is lighted by a lamp placed inside. Brass armored conduit was used throughout. The climatic conditions are very severe, and ordinary rubber insulation will not stand, so a special grade of insulation, made by the Okonite company, was used—over 175,000 feet of conduit (Interior Conduit and Insulation Company) and 110,000 feet of Okonite cable.

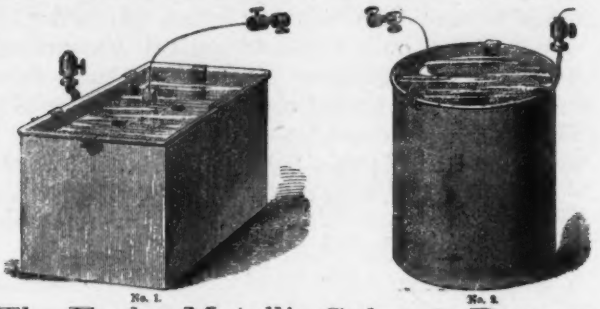
A special feature in the work is the absence of joints in the wire, all the wire being run in loops to connecting points. This allows the removal and replacing of any wire in the buildings without disturbing any others. In order to reach the lamps placed on the garden walls, it was necessary to run the wires underground. The soil eats away iron pipes in a short while, so special care had to be taken to protect the underground wires. A wooden trough was first placed in the ground and in this the wires in brass-armored conduit were laid and surrounded with pitch, which was kept from becoming brittle by mixing it with wax. In the dynamo room a handsome marble switchboard has been placed, and on it ammeters, voltmeters and a balance voltmeter of the standard Weston illuminated dial type. Pressure wires run to seven points of the system and give the pressure at these points by connection at the switchboard. The variation at no time exceeds 1 per cent. above or below the normal voltage. The electroliers are all fitted with the standard three-way switch of the General Electric Company, allowing the turning on or off of any number of lights. These switches have milled heads and are placed just under the bowl or central part of the electrolier, where they are unobtrusive and easily reached. The whole system has been installed in the most thorough and workmanlike manner, and reflects great credit on the electrician, Mr. H. E. Best, who designed the cabinets and planned and supervised the whole installation. There are over 6,000 lights in the two hotels.

Electrical Advertising Twenty Years Ago.

The removal of The Electrical World to its new quarters in the building adjoining the one in which twenty years ago its immediate predecessor, The Operator, occupied its first office, recalls the enormous growth of the electrical industries in that period, and in no way is this growth better illustrated than by a comparison between those early days and the present time in the number and character of the advertising announcements of those engaged in electrical pursuits.

We print with this reproductions of advertisements that appeared in the columns of The Operator two decades ago,

EAGLES' METALLIC BATTERY.



No. 1. No. 2.

The Eagles Metallic Galvanic Battery,

PARTRICK, & CARTER, Sole Agents,

38 SOUTH FOURTH ST., PHILADELPHIA, AND 22 DEY ST., NEW YORK.

THE EAGLES METALLIC BATTERY, after two years of trial in every capacity, is now presented with *unqualified indorsements from all directions*, as being without question the **best and most powerful of all constant batteries**, and as combining in a remarkable degree the powerful effects of carbon or other acid batteries, with the constant and enduring capacities of the Callaud, Daniells or other sulphate or copper batteries.

Simple in construction, requiring no skill to set up, nor the least trouble to manage, it does its work with steadiness, economy and DOUBLE THE AMOUNT OF POWER of any sulphate of copper battery, as long as there is left in the jar an ounce of blue vitriol to consume.

When set up properly, it will not foul or give out in from three to twelve months, according to the amount of work required from it, and *always gives uniform strength of current.*

For *open circuits*, where all other gravity batteries are *acknowledged failures*, the Eagles Battery is found to be, in every respect, *a perfect success.*

and which represent almost the entire advertising business of that day, for in going over the early numbers of that journal we find the space occupied with the announcements of other firms to be very small indeed. Yet the volume of this advertising, such as it is, was really representative of the electrical business of that day, and the contrasts afforded by a glance at the hundreds of business announcements in one of the current issues of The Electrical World is a striking object lesson to those who care to obtain an idea of the extent of the great movement which has given to the latter

EUGENE F. PHILLIPS,
PROVIDENCE, R. I.,
MANUFACTURER OF
PATENT FINISHED INSULATED
Telegraph Wire.

PATENT ELECTRIC CORDAGE

Patent Rubber-covered Wire, Cables, etc.
My wires received the highest prizes—Bronze Medals—at the Cincinnati Exposition, of 1874, for the best "Office" and the best "Insulated Line Wire."

SEND FOR SAMPLE CARD AND PRICE LIST.

JOSEPH MOORE & SONS.
ESTABLISHED 1820,
535 & 537 CHINA ST.,
(Below Green St.) Philadelphia, Pa.,
Insulated Wire Manufacturers.

INSTRUMENT & OFFICE WIRES,
FLEXIBLE CORDS, CABLES,
HEAVY INSULATED LINE WIRE,
RESISTANCE WIRE.
Wire of every variety of Insulation.

part of the nineteenth century the distinctive name of "The Electrical Age."

It is noteworthy that those who twenty years ago were most prominently in the electrical business still remain in the front rank, though some have transferred their attention to other departments of the great field they assisted in opening up.

The oldest firm represented is that of Joseph Moore & Sons, of Philadelphia, which was founded in 1820, and is now continued by Mr. Moore's son, Mr. Alfred F. Moore, with whom, however, is associated Mr. A. Bournonville and Mr. C. C. King.

Another pioneer Philadelphia firm whose advertisement appeared in The Operator two decades ago—and which, it may be added, has never been out of it or of its successor for a single issue since, The Electrical World, moreover, being the only electrical journal in which this firm carries an advertising announcement—is Partrick & Carter, established in 1867, and now doing business a few squares, as tehy say in the Quaker City, away from its original location on South Fourth street. Mr. Partrick himself died a decade or more ago, but Mr. Carter is still the superintendent of the factory, while two young men—Messrs. Charles M. and E. Ward Wilkins—who had grown up in the employ of Partrick & Carter, are the other members of the firm.

The business of L. G. Tillotson & Co., which, after the death of Mr. Tillotson, was incorporated under the title of The E. S. Greeley & Co., was founded by L. G. Tillotson and Gen. E. S. Greeley in 1865, though Mr. Tillotson had previously been engaged in the same business. The original

The "Snapper" Sounder.

PRICE 20 CENTS. $2.00 per doz $1.40 1-2 do

Trade Mark. Patented May 13, 1874.

Polished nickel-plated base, 40c., or 6 for $2

Polished, with Knob and Screw Fastenings, 75c.

PRICE 75 CENTS.

Sent post-paid on receipt of price

E. W. POPE, Box 5378, N. Y.

location of the firm was 8 Dey street, directly opposite its present place of business, to which it moved when the old quarters were vacated to make room for the Western Union Building. Thus, for almost thirty years, The E. S. Greeley & Co., or the firm which preceded it, has had its headquarters in the same street.

The name of Eugene F. Phillips, whose annual Rhode

EDISON'S INK RECORDER,

For Amateur Students and Private Lines.

[Patent applied for.]

SEND FOR CIRCULAR.

EDISON & MURRAY,

10 and 12 WARD STREET,

NEWARK, N. J.

Island clambake has been the means for many years of introducing newcomers in the electrical business to the "Old Timers," and thus furnishing a connecting link between the past and the present, was relatively as familiar in the olden days as it is now, and almost as popular.

It is but natural that in an electrical journal of twenty

years ago we should meet with the name of Edison, though up to that time he had confined his inventive genius to the sphere of telegraphy. While he was well known at this early day, and had been one of the earliest contributors to the reading columns of The Operator, the great achievements which have immortalized his name had their birth in the half dozen years subsequent to 1874. Among those connected in business with Mr. Edison about this period was Mr. Franklin L. Pope and the late Mr. James N. Ashley. A

A CARD.

THE METALLIC GALVANIC BATTERY.

A Notice having been extensively published and circulated announcing the appointment by Edwin Eagles of another firm as sole agents for the manufacture and sale of the Metallic (or Lead) Galvanic Battery, known to the trade as the "Eagles Metallic Galvanic Battery," and enjoining all other parties from manufacturing or selling the battery, we take this method of informing the public of our position and rights in regard to said battery.

At the time the notice referred to was prepared and published it was well known to Eagles, as well as to us, that his application for a patent on the battery had been rejected more than a year previous, on the ground that the applicant was not the original inventor.

The original inventor of the battery now has an application pending in the Patent Office for a patent on his invention, which we have no doubt will be granted, and which, when issued, will be controlled by us.

In any case the notice is preposterous, as in no event can a valid patent possibly be issued to any other than the original inventor.

We continue and shall continue to manufacture and sell said Metallic Galvanic Battery, and parties purchasing of us will be fully protected in their right to sell and use the same.

Those who may purchase this battery manufactured by other parties not authorized by us, will be, after the issue of the patent, legally liable to pay royalty to us on battery so purchased from or made by unauthorized parties.

The Metallic (Lead) Galvanic Battery may be had of us, or from Messrs. L. G. Tillotson & Co., who are our agents for its sale, at our prices, and who will guarantee against infringement in any battery that they sell.

F. L. POPE & CO.,
38 Vesey Street.

NEW YORK, Dec. 9, 1874.

IF YOU WANT
EQUIPMENTS
FOR A
Telegraph Line.
ORDER OF
L. G. TILLOTSON & CO
They have the GREATEST VARIETY.
They carry the LARGEST STOCK.
Their PRICES are the LOWEST
and QUALITY THE BEST
THEY GUARANTEE
EVERYTHING TO BE AS REPRESENTED
They always RECTIFY MISTAKES at their OWN EXPENSE.
EVERY ARTICLE REQUIRED FOR THE
Construction and Operation of Lines
ALWAYS ON HAND
AMONG THEM
EXCELSIOR
TELEGRAPH INSTRUMENT FOR STUDENTS
Comprising Sounder and Key, is the greatest success of the times.
We are offering 20 per cent. discount from list prices on all instruments of our manufacture.
L. G. TILLOTSON & CO.

Mr. Murray, however, a grocer, had furnished the money for the firm of Edison & Murray, one of whose advertisements is here reproduced.

Another familiar name is that of Mr. Ralph W. Pope, now the genial secretary of the American Institute of Electrical Engineers, who was the inventor of the, in its day, widely known "snapper" sounder mentioned in the advertisement. The idea of this popular instrument was conceived by Mr. Pope in a printing office one day while handling a printer's composing rule. The rule had been dented and when bent gave a note so near like that of a sounder, that he borrowed the rule and based on it the construction of the "snapper sounder."

Economy in Electrical Distribution.

BY ALBERT L. CLOUGH.

It is a well known fact that the utmost economy of distribution is attained in a system of electrical supply in which the sum of the interest on the investment plus the energy loss amounts annually to the smallest amount.

In many instances, however, this fundamental and unquestioned truth is disregarded and that system chosen which offers the possibility of starting the plant with the least expense, leaving the matter of future efficiency out of the question. In this way a great many stations have been equipped with the alternating system which would in the end have been better served by the three-wire method of distribution. Both of these systems have their advantages and defects and their conditions of greatest and least adaptability, which it may be well briefly to review.

In the alternating current system a constant loss, independent of the number of lamps operated, is experienced, which is due to the hysteresis and eddy currents in the transformers. This loss amounts to about 5 per cent. of the total capacity installed, and at low loads reduces the efficiency of the system to a ridiculously small amount. It may amount in extreme cases to many times the useful energy distributed.

The copper required for a given conductor loss in the alternating system is, as is well known, only about 1-32 that required in the three-wire system for the same amount of energy transmitted.

The three-wire system, on the other hand, reaches its maximum efficiency of distribution at its very lightest loads, and can only handle large loads commercially within comparatively small areas.

In the handling of large loads at a considerable distance the alternating system thus reaches its highest degree of usefulness, while the direct system can only overcome distances of any magnitude, with efficiency, when the call for current is small.

Now in most central stations there is a large demand for current only during six or seven hours in the evening. During the rest of the twenty-four hours the rate of supply falls to a very small fraction of the maximum, notably during the hours from midnight until morning and during the sunny hours of the day.

If a practicable combination of the two methods of supply could be devised, employing each during the period of its greatest adaptability, much improvement might result. The alternating current would be used—at its best—during the heavy load, while the use of the direct current during the rest of the time would do away with the uneconomical conditions brought about by the constant transformer losses.

Some effort must have been expended by inventors toward the solution of this problem, but not much seems to have been accomplished. The following diagram may possibly furnish a hint in the right direction. Referring to the figure, D represents a source of direct and of alternating current which may be, as here shown, a dynamo capable of furnishing both; its direct current output being used in connection with a storage battery, B, in order to make use of a three-wire circuit, or it may be the combination of an alternating current machine and two direct current machines, arranged in the usual way. The alternating current is supplied to the bus bars $M\,M$ and the direct current to the three busses $N\,N\,N$. From $M\,M$ extend the two feeders $M_1\,M_1$ through the double pole switch S_1 to the transformer primaries of the two representative consumers' stations P_2 and P_2, and from $N\,N\,N$ are run through the triple pole switch S_2 the three feeders $N_1\,N_1\,N_1$ connected to the lamps of the two consumers through their transformer secondaries. $H\,H$ are automatic devices placed at certain points in the three-wire system to short circuit the mains while the alternating current is in use.

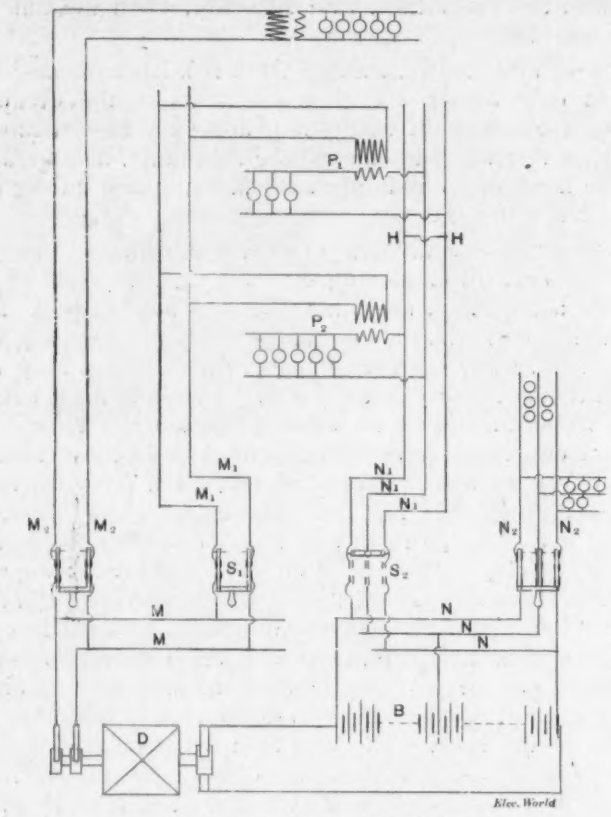
The operation of the arrangement is as follows: During the hours of large demand the switch S_1 would be closed and switch S_2 open and the lamps would be supplied on the alternating system in the usual way, with the exception that the devices $H\,H$, having acted, would form, by short circuiting $N_1\,N_1\,N$, a common return for the currents in the house circuits. The transformer secondaries would be distributed upon the three-wire mains so as not only to balance the two sides, but, furthermore, there would be the same number of transformers poled in the same direction on each side so as to reduce the current in the common conductor. The transformers are not in parallel, as might for the moment be thought to be the case.

During times when the call for current is light switch S_2 would be closed and switch S_1 would be open, and the lamps would be operated as from an ordinary three-wire system, the presence of the transformer secondaries producing only a very small drop.

The claim made for the arrangement is that the saving in constant transformer losses would far more than pay the interest upon the extra three-wire feeders ($N_1\,N_1$) at least within certain limits of distance and of load factor. The current required from the direct current conductors being

so small, owing to the period of the day during which they are used, calls for comparatively small wires, and the absolute amount of energy distributed is so inconsiderable that a larger percentage loss than usual may be allowed. The fact that the extra conductors would be run upon the same poles with the alternating wires is a point to be considered.

In the diagram M_2, M_2 are alternating current feeders supplying remote and scattered districts continuously by alternating current, and N_2, N_2, N_2 is a three-wire network serving continuously a region immediately about the station.



PROPOSED SYSTEM OF DISTRIBUTION.

It is believed that between these two classes of consumers and in certain conditions of the load factor a combined system would possess an advantage in economy.

An Unpatented Improvement in the Magneto Telephone.

BY ROBERT E. FORD.

The idea mentioned by Mr. Gifford in The Electrical World of March 31, of superimposing a closed secondary coil upon the coil of a magneto telephone, has also been tried by the writer on a private experimental line.

The line was 750 feet long, with ground return. For 400 feet it ran parallel to two alternating incandescent circuits, an arc circuit and a street railway line. The instrument used had a 150-ohm coil, around which was laid a secondary coil of 100 turns, and outside of this was a thin metallic shell.

With the secondary open and the shell removed, the roar due to the induction from the alternator circuit was so loud as to make conversation difficult, and when an electric car was working up speed on that section of the road, all transmission of speech was out of the question.

The addition of the metallic shell did not appreciably reduce these objectionable effects. When the secondary circuit was closed, however, the roar was cut down about one half, the articulation becoming more distinct and giving a tone corresponding to the reversals in the alternator line. The loudness of the speech was also affected to a certain extent, and its distinctness increased, rendering conversation more satisfactory and without interruption.

The reason why these results in the matter of the metal case do not agree with those of Mr. Gifford is probably on account of the very large amount of cross-induction, but may also be due to the large size of the principal coil.

Calculating Magnet Coils.

BY C. H. BEDELL.

The constant use of tables of copper wire, as published, has made us so familiar with them that it is possibly useless to suggest a change, even if that change is nothing more than an addition. To those, however, who make frequent use of the tables for calculations of field winding—and they are not few, but many—one more column is of great help, saving much time and rendering results more certain.

It is well known that a certain voltage at the terminals of a piece of wire of a given size will correspond to a definite number of ampere feet, whether the piece be long or short, if the temperature remains the same. For example, 1,000 feet of No. 10 B. & S. wire has a resistance of about 1 ohm; if a potential of one volt be maintained at the terminals of that 1,000 feet, about one ampere will flow, giving a total of 1,000 ampere feet. With 2,000 feet of the same wire, having one volt maintained at its terminals, only half the current will flow, as we have double the resistance, but we will again have a total of 1,000 ampere feet. In the same way every wire has a definite number of ampere feet per volt, and the ampere feet of any wire for any voltage can be obtained by multiplying the ampere feet per volt for that wire by the voltage used.

American gauge, B. & S. number.	Ampere feet per volt.	American gauge, B. & S. number.	Ampere feet per volt.
0000	20,383	19	120.6
000	16,166	20	98.40
00	12,819	21	78.03
0	10,172	22	61.91
1	8,062	23	49.07
2	6,394	24	38.92
3	5,070	25	30.86
4	4,021	26	24.47
5	3,189	27	19.41
6	2,529	28	15.39
7	2,005	29	12.21
8	1,590	30	9.681
9	1,261	31	7.857
10	1,000	32	6.088
11	793.2	33	4.829
12	629.0	34	3.828
13	498.8	35	3.036
14	386.0	36	2.408
15	321.0	37	1.909
16	248.8	38	1.514
17	197.4	39	1.201
18	156.5	40	.9528

In calculations of the field of a machine, find the ampere turns required, then the ampere feet, knowing the average length of a turn. If this number of ampere feet be divided by the voltage used, we obtain the ampere feet per volt that the right size of wire will give. By referring to the above table the nearest size of wire can immediately be obtained. The amount of that wire which must be used is, however, another consideration.

(The numbers in Mr. Bedell's table representing the ampere feet per volt are evidently the same as those representing the number of feet per ohm, the values of which are given in many tables.—Ed.)

Electric Cooking and Heating.

Mr. R. E. Crompton, in a recent interview in the "Pall Mall Gazette," gives some facts and figures in regard to electric cooking and heating. On a 100-volt circuit, he said, it took 25 amperes to heat up a small family oven, which would then cook for nearly an hour. A frying pan requires 2 1-2 amperes, and it costs one-third of a cent (with electricity at 8 cents per kilowatt) to heat an ordinary tea kettle. A flatiron takes from 2 1-2 to 3 amperes of current, and a soldering iron 1 1-2 amperes.

The Practical Importance of Resonance in the Transmission of Electrical Power.

BY F. W. DUNBAR.

THE rapid strides which have recently been made in the transmission of electrical power to great distances have increased the practical importance of so designing the circuit that a given current may be transmitted with a minimum cost of copper. It has become so customary in the designing of circuits for the transmission of steady or continuous currents in which the current follows Ohm's law to neglect the capacity and inductance of the circuit, that the effect of these two factors, which are all important in the transmission of power by alternating currents, are either entirely neglected or considered as correction factors, and as necessarily detrimental to the transmission of alternating currents.

The object of these articles is to bring forward the practical importance of these two factors, C and L, to point out the laws which govern their effect upon the current and to show that instead of being detrimental to a correctly designed circuit, they may become of great practical utility and will allow a far greater economy of copper in a circuit properly designed to respond to a given period of alternation than can be secured by means of the direct current *at the same voltage.*

In other words, while the current which can be produced by a direct E. M. F. in a given circuit is $\frac{E}{R}$, it can readily be shown that by suitably adjusting the electro-static capacity and electro-magnetic inductance upon this same circuit it may be made to deliver a current at the distant end for a definite rate of alternating E. M. F. far in excess of $\frac{E}{R}$.

It is, however, almost universally true that with the existing methods of circuit construction the values of C and L which occur are not at all suited for securing this economy of copper with the ordinary low rates of alternation, and that with few exceptions the current which is received at the distant end is less than would be secured with a steady E. M. F. of equal (average or maximum) value.

It may be readily shown that the physical dimensions of the electrical units C and L are respectively the reciprocal of an acceleration and a length. But the motion resulting from an impressed sinusoidal force is given by the law $t = \sqrt{\frac{4\cdot\pi^2 \text{ displacement}}{\text{acceleration}}}$, where t is the time.

Thus the motion of a simple pendulum is given by $t = 2\pi\sqrt{\frac{l}{g}}$, where l = length and g = acceleration of gravity. We see at once, then, that the electrical circuit will assume under the impressed alternating E. M. F. $e = E \sin \omega t$, a harmonic vibration of the period $t = K\sqrt{\frac{L}{C}}$. K will be determined later

It at once follows that if every electrical circuit possesses a particular pitch or rate of its own, then it will respond perfectly only to that pitch or some of its overtones. Just as an organ pipe or piano string will respond perfectly only to its own natural rate of vibration or its overtones.

But if we take a long, light string, very loosely stretched, it is quite evident that it will possess no marked pitch of its own, and will be able to respond, to some extent, to any rate of vibration impressed upon it. But if these vibrations be impressed at one end of the string, they rapidly die out during the period of traversing the string, and by the time the distant end is reached may have but a small fraction of their original value. The energy which would have been perfectly transmitted to the distant end had the string been tightly stretched and of heavier material, has in this case been largely absorbed by the light, inelastic string, and dissipated as heat. This is the case with the electrical circuits of to-day. They are constructed with little electrical inertia or weight, and so much electrical capacity (reverse of mechanical tension), that they possess no marked pitch of their own, and are consequently, like the light, loose string, capable of imperfectly responding to any period of vibration forced upon them, and of transmitting that vibration with a considerable loss to the distant end. If, now, the string be kept at the same tension, and the material be increased in size and weight, it is evident that the natural period of the string will become more and more prominent, and it will respond to and transmit that rate of alternation with little or no loss—and remain practically inert for all other rates—save the overtones of this fundamental.

Similarly, if the electrical inertia (inductance) of the current be increased, the natural period of vibration will assert itself, and if that vibration, or its overtones, be impressed upon it, little loss will occur during transmission, but the circuit will be practically incapable of responding to any other rates. Again, if the tension of the string be increased, or the capacity of the circuit be decreased, similar results will follow. It is obvious, however, that if the string be so light that the friction of the air, or other medium, seriously interferes with its vibration, then perfect resonance is impossible. Similarly it will be found that unless the inductance be made large in comparison with the electrical friction (resistance), then complete resonance will be impossible in the electrical circuit.

The method of the following articles will be to first determine those values of C and L which will bring an electrical current into resonance for a given period of vibration, and then to show graphically and analytically the advantages and economy of copper, secured by a resonant circuit.

Although the fundamental equations of E. M. F. and current have been derived by Mr. Heaviside for a circuit containing distributed resistance, inductance and capacity, they are here reproduced in the form most convenient for farther treatment.

The leakage factor has been omitted entirely, and for the following reasons: The leakage of a well constructed line is negligible, except during excessively wet or foggy weather, and during these exceptional times the effect of the leakage may be counterbalanced by a slight change in the rate of alternation.

Let the sinusoidal E. M. F., $2e = 2E \sin \omega t$, act upon the closed metallic circuit of length l, where $\omega = 2\pi N$. and N is the number of complete alternations per second.

Let R, C and L be respectively the resistance in ohms, the capacity in farads and the inductance in henrys, per mile of conductor.

Then at any point x, the drop of voltage through the differential length dx is:

$$de = iR\,dx + \frac{di}{dt} L\,dx, \qquad (1)$$

or is equal to the current × resistance plus rate of change of current × inductance.

Again, as the capacity is uniformly distributed, the quantity of the "bound" charge at any distance x is

$$dq = C\,dx\,e = \int_o^t di\,dt; \text{ or } C\frac{de}{dt} = \frac{di}{dx}. \qquad (2)$$

These two equations determine the entire action, and are sufficient to determine the solution, which is known to be

of the form $e = k\,\varepsilon^{p x + q t} \sin(\beta t + a x)$, where ε = Napierian base 2.718+.

This, when $x = 0$, reduces to $e = k\,\varepsilon^{q t} \sin \beta t$.

But by assumption the E. M. F. at the origin, on either wire, is $e = E \sin \omega t$; hence $k = E$, $q = 0$, and $\beta = \omega$, and

$$e = E\,\varepsilon^{p x} \sin(\omega t + a x). \qquad (3)$$

The constants p and a remain to be determined. From (2) we get

$$C \frac{de}{dt} = C E\,\varepsilon^{p x}\,\omega \cos(\omega t + a x) = \frac{di}{dx}.$$

Integrating we have

$$i = \frac{C E \omega}{p^2 + a^2}\,\varepsilon^{p x} \left\{ p \cos(\omega t + a x) + a \sin(\omega t + a x) \right\}$$

Rendering this equation identical with (1) and equating the coefficients we have

$$\left.\begin{aligned} \frac{de}{dx} &= p\,\varepsilon^{p x} \sin(\omega t + a x) + a\,\varepsilon^{p x} \cos(\omega t + a x). \\ -R i &= -\frac{R C \omega a}{p^2 + a^2}\,\varepsilon^{p x} \sin(\omega t + a x) - \frac{R C \omega p}{p^2 + a^2}\,\varepsilon^{p x} \cos(\omega t + a x), \\ -L \frac{di}{dt} &= \frac{L C \omega^2 p}{p^2 + a^2}\,\varepsilon^{p x} \sin(\omega t + a x) - \frac{L C \omega^2 a}{p^2 + a^2}\,\varepsilon^{p x} \cos(\omega t + a x). \end{aligned}\right\} E$$

or

$$p - \frac{R C \omega a}{p^2 + a^2} + \frac{L C \omega^2 p}{p^2 + a^2} = 0,$$

and

$$a - \frac{R C \omega p}{p^2 + a^2} - \frac{L C \omega^2 a}{p^2 + a^2} = 0.$$

Solving we have

$$\left.\begin{aligned} p &= \pm \sqrt{\frac{C \omega}{2}}\,\sqrt{(R^2 + L^2 \omega^2)^{\frac{1}{2}} - L \omega}, \\ \text{and} \\ a &= \pm \sqrt{\frac{C \omega}{2}}\,\sqrt{(R^2 + L^2 \omega^2)^{\frac{1}{2}} + L \omega}. \end{aligned}\right\} \qquad (4)$$

The double sign indicates that on both conductors of the circuit waves of equal magnitude and opposite phase are sent out and at any distance, x, the potential of one conductor is

$$E\,\varepsilon^{-p x} \sin(\omega t - a x).$$

and of the other

$$-E\,\varepsilon^{p(-x)} \sin(\omega t + a(-x)).$$

Now, it is evident that each of these impulses decreases in magnitude with an increase in the distance from the origin, and finally vanishes only when $x = \infty$, that is, each of these two impulses, starting simultaneously at the origin, and always of equal magnitude and opposite phase, traverses the circuit of finite length, l, in opposite directions, an infinite number of times with continually decreasing amplitude: just as the waves formed by plucking, at a certain point, a wire rope, suitably supported and stretched into a complete loop, would continue to traverse the circuit of the rope until their amplitude became zero.

Considering the point, x, on one conductor of the circuit, the value of the positive wave after traversing the circuit n times would be

$$e_n = E\,\varepsilon^{-p(x + n l)} \sin\left\{ \omega t - a(x - n l), \right\}$$

and the combined effect of the waves summed to infinity is

$$e_R = E\,\varepsilon^{-p x} \sum_{n=0}^{n=\infty} \varepsilon^{-p l n} \sin\left\{ \omega t - a(x - n l), \right\}$$

Similarly the combined effect of the negative waves is

$$e_{-R} = -E\varepsilon^{-p(l - x)} \sum_{n=0}^{n=} \varepsilon^{-p l n} \sin\left\{ \omega t - a(l - x + n l). \right\}$$

Combining the waves and separating the summation terms we have

$$e = E \left\{ \begin{aligned} &\sum_{n=0}^{n=\infty} \varepsilon^{-p l n} \cos a l n \left\{ \varepsilon^{-p x} \sin(\omega t - a x) - \right. \\ &\qquad \left. \varepsilon^{-p(l - x)} \sin(\omega t - a l + a x) \right\} - \\ &\sum_{n=0}^{n=\infty} \varepsilon^{-p l n} \sin a l n \left\{ \varepsilon^{-p x} \cos(\omega t - a x) - \right. \\ &\qquad \left. \varepsilon^{-p(l - x)} \cos(\omega t - a l + a x). \right\} \end{aligned} \right\}$$

But $$\sum_{n=0}^{n=\infty} \varepsilon^{-p l n} \cos a l n = \frac{\varepsilon^{p l} - \cos a l}{\varepsilon^{p l} + \varepsilon^{-p l} - 2 \cos a l}$$

and

$$\sum_{n=0}^{n=\infty} \varepsilon^{-p l n} \sin a l n = \frac{\sin a l}{\varepsilon^{p l} + \varepsilon^{-p l} - 2 \cos a l}.$$

Substituting and replacing $\frac{\varepsilon^{p l} + \varepsilon^{-p l}}{2}$ by $\cosh p l$, we have

$$e = \frac{E}{2(\cosh p l - \cos a l)} \left[(\varepsilon^{p l} - \cos a l)(\varepsilon^{-p x} \sin(\omega t - a x) - \varepsilon^{-p(l - x)} \sin(\omega t - a l + a x)) - \sin a l (\varepsilon^{-p x} \cos(\omega t - a x) - \varepsilon^{-p(l - x)} \cos(\omega t - a l + a x)).) \right] \qquad (5)$$

Combining the terms with respect to ωt we get

$$e = E \sqrt{\frac{\cosh(p l - 2 p x) - \cos(a l - 2 a x)}{\cosh p l - \cos a l}}\, \sin(\omega t - \tan^{-1} I). \qquad (6)$$

Where $I = \frac{\sinh(p l - p x) \sin a x - \sinh p x \sin(a l - a x)}{\cosh(p l - p x) \cos a x - \cosh p x \cos(a l - a x)}$.

This equation expresses the magnitude and phase of the E. M. F. at any point and at any time and for all values of R, C and L except the value $C = 0$. For this value of C the equation is indeterminate, but in two operations reduces to the form

$$e = E \left(1 - \frac{2 x}{l}\right) \sin \omega t. \qquad (7)$$

showing a uniform drop in voltage throughout the circuit and no displacement of phase.

When $x = 0$ (6) reduces to $e = E \sin \omega t$, as per assumption. When $x = \frac{l}{2}$ the equation reduces to $e = 0$.

That is, as we have assumed equal position and negative

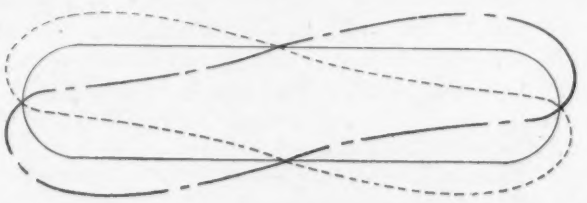


FIG. 1.

values of the E. M. F. at the origin at every instant, the potential of the middle point of the circuit is always halfway

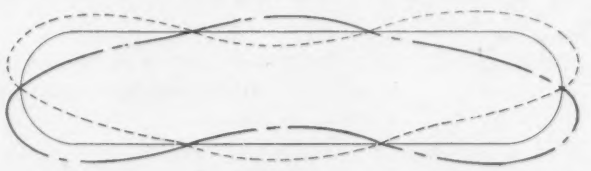


FIG. 2.

between the potential of the two sides at the origin. The phase of the E. M. F. at this point is $\sin(\omega t - \tan^{-1} 0) = \sin(\omega t - n \pi)$ where n has all positive integral values including 0. That is, the phase of the E. M. F. may coincide with, or be displaced one-half a wave length from, the E. M. F. at the

origin, according as the circuit divides itself into an even or an odd number of wave lengths. Thus, in Fig. 1, the circuit is divided into an even number of wave lengths (two), and the phase at the distant end coincides with the phase at the origin; that is, it differs by an even multiple of π from the origin. But in Fig. 2 the circuit divides into an odd number of wave lengths, and consequently the phase differs from the origin by 180 degrees or some odd multiple of 180 degrees.

The equations for the current are similarly derived, thus introducing in equation (5) the relation,

$$C\frac{de}{dt} = \frac{di}{dx}, \text{ we have}$$

$$C\frac{de}{dt} = \frac{di}{dx} = \frac{C E \omega}{2(\cosh p l - \cos a l)}$$

$$\Big[(\varepsilon^{p l} - \cos a l)\Big(\varepsilon^{-p x}\cos(\omega t - a x) - \varepsilon^{-p(l-x)}$$

$$\cos(a t - a l + a x)\Big) + \sin a l\Big(\varepsilon^{-p x}\sin(\omega t - a x) -$$

$$\varepsilon^{-p(l-x)}\sin(\omega t - a l + a x).\Big)\Big]$$

Integrating and combining the terms with respect to ωt we get

$$i = -\frac{E}{\sqrt{(R^2 + L^2\omega^2)^{\frac{1}{2}}}}\sqrt{\frac{\cosh(p l - 2 p x) + \cos(a l - 2 a x)}{\cosh p l - \cos a l}}$$

$$\sin(\omega t + \tan^{-1} y - \mu), \qquad (8)$$

where $y = \dfrac{\cos a x \sinh(p l - p x) + \cos(a l - a x)\sinh p x}{\sin a x \cosh(p l - p x) + \sin(a l - a x)\cosh p x}$

$$\text{and } \mu = \tan^{-1}\frac{a}{p}.$$

This equation expresses the value of the current at any distance, x, from the origin at any time, t, and with all values of R, C and L save $C = 0$. For this value of C it is indeterminate, but reduces in two operations to

$$i = -\frac{2E}{l\sqrt{R^2 + L^2\omega^2}}\sin\left(\omega t - \tan^{-1}\frac{L\omega}{R}\right), \qquad (9)$$

which is the well-known form for the current in a circuit devoid of capacity.

(It must always be borne in mind that the maximum value of the impressed E. M. F. is $2E$.)

The negative sign indicates simply that the direction of the "flow" of the current is opposite to an increase in potential and will hereafter be omitted.

The current at the origin is given when the condition that $x = 0$ is imposed upon equation (8), thus

$$i_o = \frac{E}{\left(\dfrac{\sqrt{R^2 + L^2\omega^2}}{C\omega}\right)^{\frac{1}{2}}}\sqrt{\frac{\cosh p l + \cos a l}{\cosh p l - \cos a l}}$$

$$\sin\left\{\omega t - \mu + \tan^{-1}\frac{\sinh p l}{\sin a l}\right\} \qquad (10)$$

The current at the distant end is given when the condition that $x = \dfrac{l}{2}$ is imposed upon equation (8) thus

$$i_{\frac{l}{2}} = \frac{E}{\left(\dfrac{\sqrt{R^2 + L^2\omega^2}}{C\omega}\right)^{\frac{1}{2}}}\frac{\sqrt{2}}{\sqrt{\cosh p l - \cos a l}}$$

$$\sin\left\{\omega t - \mu + \tan^{-1}\frac{\tanh p\frac{l}{2}}{\tan\frac{a l}{2}}\right\} \qquad (11)$$

The factor $\left(\dfrac{\sqrt{R^2 + L^2\omega^2}}{C\omega}\right)^{\frac{1}{2}}$ is the impedance or "apparent resistance" of the circuit per mile.

The factors $\sqrt{\dfrac{\cosh p l + \cos a l}{\cosh p l - \cos a l}}$ and $\sqrt{\dfrac{2}{\cosh p l - \cos a l}}$ express the "apparent length" of the circuit at the origin and distant end respectively.

Equations 10 and 11, expressing the values of the current at the transmitting and at the receiving end respectively, are the important fundamental equations for a circuit containing distributed resistance, capacity and inductance.

Laboratory Notes—XVIII.

BY LIEUT. F. JARVIS PATTEN.

A NEW SYSTEM OF POLYPHASE DISTRIBUTION.

THE entire feasibility and evident advantage of combining biphase and triphase working in the same system of distribution, using each where it could work to the best advantage and economy, was indicated, probably for the first time, in a paper read before the recent Washington convention by Mr. Scott. The method shown of combining the two systems is strikingly novel and simple, and its importance seems evident from the attention it has drawn from all quarters. Mr. Scott's description of his double system as well as Mr. Steinmetz's later article on the transformation of alternating currents, which is chiefly directed to the same end, will make

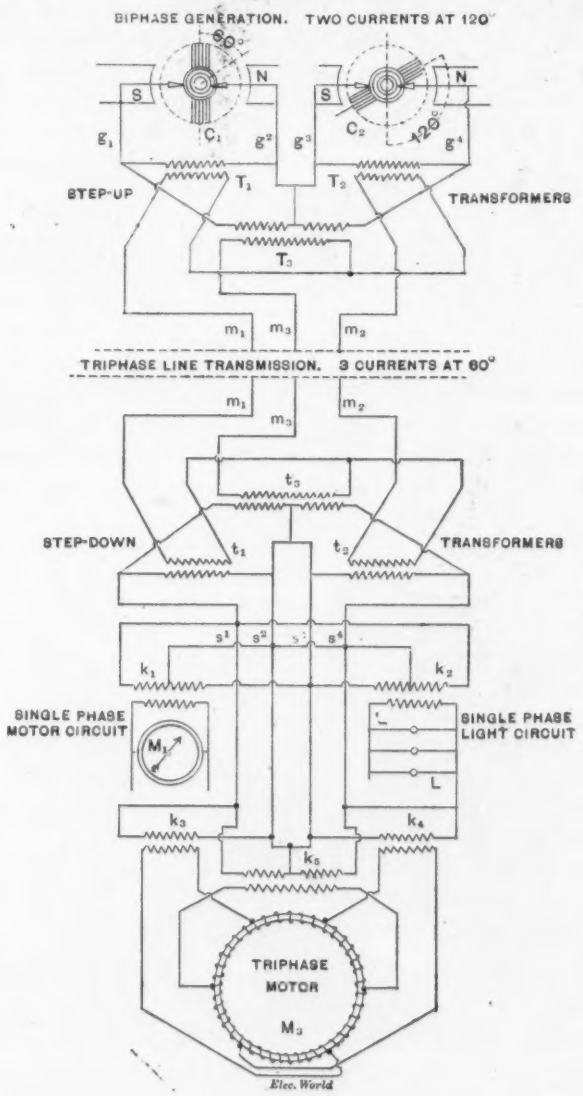


FIG. 52.

the following description of an entirely different way of obtaining similar results timely at this moment.

The advantage arising from a combination of biphase and triphase working in the same system rests apparently on the superior economy of the latter for line transmission, and the

better adaptability of the former to distribution under varying loads of different sorts.

The plan in general terms is one in which biphase currents at the generating station are there transmitted to triphase currents for line transmission (presumably in the step-up transformers); three line wires take

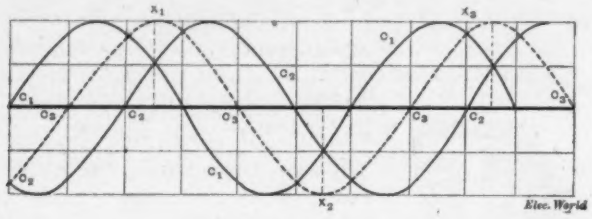


FIG. 53.

these currents to the point of distribution, where the step-down transformers change them back to biphase currents in quadrature.

As remarked by Mr. Steinmetz, in his article, any polyphase system is readily transformed to any other polyphase system—biphase currents to triphase currents, or the reverse, in a single transformer without any moving part. It is only necessary to use a transformer of the ring type or one in which polyphase currents of any order set up a rotating field; then evidently from the secondary of such a transformer polyphased currents of any other order may be derived. Not only this, but either biphase or triphase currents may be in like manner transformed to a single alternating current that will tax the two biphase or three triphase circuits equally, and thus secure an equal distribution of the single-phase load among the different circuits of a biphase or triphase system, which is a salient feature of the system of distribution here presented. The latter transformation, when applied to changing biphase currents to a single phase current, does not even require a rotary field transformer or one of the ring type, but may be of the ordinary form provided with a double primary winding supplied with separate alternating currents, having a phase difference of 90 degrees, and a single secondary that will have a resultant single phase current that, whatever its load, will tax the two biphase currents equally. This transformation was explained and used by me several years ago.

The general features of the new system of distribution, which secures a combination of all three systems of working in one, and which also insures an equal loading of the multiphase circuits, under various conditions of supply, is shown in Fig. 54 by a diagram of circuits.

At the generating station a double machine generates two independent alternating currents. They are biphase currents, but are not in quadrature relation to each other, the separate armature coils being so adjusted that the two currents have a phase difference of 120 degrees, and of the same E. M. F. These currents will be then represented by the two full line curves, C_1 and C_2, Fig. 53, and the dotted line curve C_3, same figure, would represent their resultant, or, if C_1 and C_2 were secondary currents derived from those first generated by the two armatures, then C_3 would represent a resultant secondary current derived from both primaries by using a transformer of the type referred to, and such a secondary would of course load both the primary biphase circuits alike.

Owing, however, to the phase difference of 120 degrees between the two primaries, the resultant secondary current will be midway between the other two currents, C_1 and C_2. It will be easy to arrange matters so that this secondary resultant will have the same maximum voltage as the others, when we will have three currents in triphase relation, having 60 degrees phase difference, and if the connections of the circuit conveying the current represented by the dotted curve be C_3 reversed at the translating device, we would have three currents of 120 degrees phase difference and a balanced system.

Using these principles, we have, therefore, at the generating station three step-up transformers T_1, T_2, T_3 (Fig. 54), the latter only being a double transformer, as indicated. These transformers deliver the three currents C_1, C_2, C_3 in triphase relation to the lines m_1, m_2, m_3. At the distant end a step-down transformer of the ring type, may be used, in which the triphase currents will produce a rotary field, and if we connect to the secondary of this transformer for four points, 1, 2 and 3, 4, we will have on the mains M_1, M_2, M_3, M_4 two currents in quadrature relation for local distribution. To these mains biphase motors will necessarily load the two circuits equally. To accomplish the same result with respect to lighting as well, the double transformer is availed of as indicated, that yields a single alternating current for lighting which taxes the two biphase currents equally.

Again, if it is desired to operate triphase motors at the point of supply, another system of derivation by means of triple transformers similar to that used at the generating station for changing biphase to triphase currents. Such a complete system is shown in Fig. 52, where the system of generation and transformation to triphase currents for line transmission is the same as before. At the point of distribution, however, the step-down transformers, instead of being rotary field transformers of the ring type, are triple

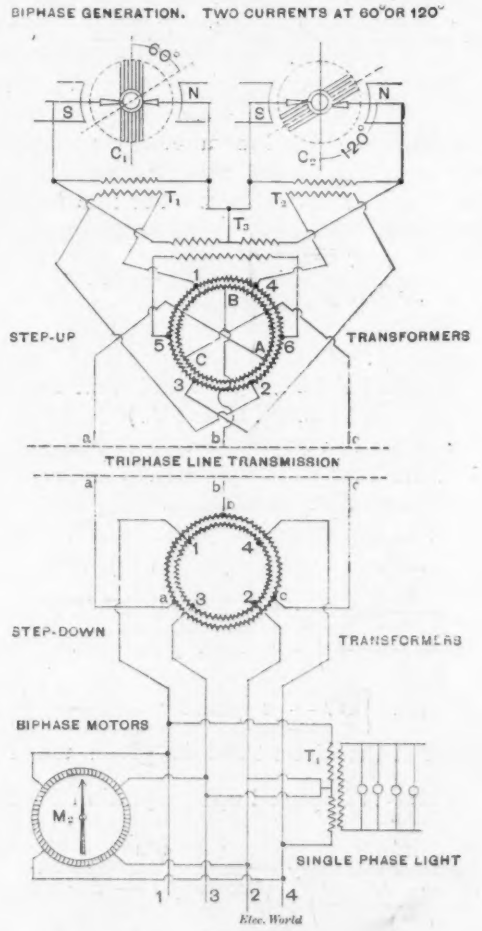


FIG. 54.

transformers like those at the generating station working backwards, yielding biphase currents having 120 degrees phase difference, and these by using double primary circuits, as shown, give a single current for single phase motors or for lighting that loads the two circuits equally, whereas a triple transformer giving triphase alternating currents at 60 degrees may be used to operate triphase motors as at M_3, Fig. 52.

We thus have in such a system facilities for operating both multiphase devices and single phase devices as single

phase motors and light, each of which individually is made to load the supply circuits equally in a way that is independent of the character of the translating device, and this is combined with whatever advantage can be derived from biphase generation and triphase line transmission.

An Electrical Engineering School of the South.

The School of Electrical Engineering at the Agricultural and Mechanical College of Alabama was established by the board of trustees in June, 1891, for the purpose of supplying educational facilities for special instruction in the in-

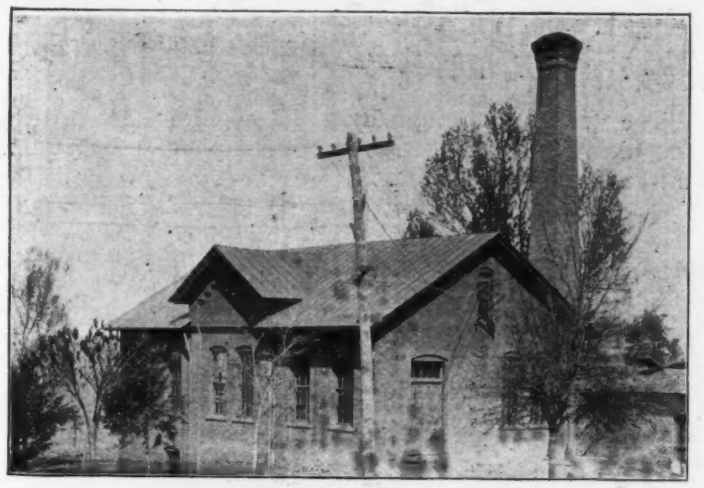


FIG 1.—EXTERIOR OF POWER STATION.

dustrial applications of electricity. It was intended to so combine theoretical and practical instruction as to give the student a knowledge of the science of electricity and magnetism in its most comprehensive sense.

The course of instruction extends through four years, and includes, besides work in electrical engineering, the study of physics, mathematics, mechanical engineering, chemistry, mechanical drawing, French or German, and practical work in physical laboratory, wood shop, forge shop, foundry and machine shop. The special study of electrical engineering begins in the junior year. In this year five hours per week for the entire session are devoted to the study of the principles of electricity and magnetism. The student is made familiar with the theoretical principles by experiments, illustrations, recitations and lectures. Six hours per week are devoted to work in the electrical laboratory. This includes management and construction of batteries and instruments, electrical measurements, and verifications of the principles upon which the measurements of current, electromotive force and resistance are based. The text books used in the junior year are Ayrton's "Practical Electricity," and Desmond's "Electricity for Engineers."

In the senior class the work is as follows: Five hours per week recitations and lectures on dynamo-electric machinery and the practical applications of electricity, three hours per week to the design of dynamo-electric machinery and six hours per week to work in the electrical laboratory, including efficiency tests of dynamos and motors, characteristics of dynamos, efficiency tests of plants, etc.

Trips are taken during the year by the senior class to different cities for the purpose of inspecting and testing plants.

There is a large number of well selected books on electricity and magnetism in the library, which are accessible to the student. Several prominent magazines on electrical engineering are received at this library.

The electrical laboratory, besides the apparatus necessary for first-year students, such as batteries, magnets, resistance coils, telegraph instruments, bells, etc., is well equipped with many fine instruments of precision for very delicate and accurate measurements, such as a tangent galvanometer (Societe Genevoise), tangent and sine galvanometer (Kohl), Edelmann's large mirror galvanometer, d'Arsonval and ballistic galvanometers, standard microfarad condenser, slide metre bridges, standard resistance boxes, etc. For measurement of current, Lord Kelvin's deka-ampere balance and graded current galvanometer, Siemens' electro-dynamometer, Weston ammeter, Queen magnetic vane ammeter, Kohlrausch ammeter, Ayrton and Perry ammeter, Deprez ammeter, and Wood ammeter, etc. For measurement of potential, Lord Kelvin's graded potential galvanometer, Weston 150-volt and 600-volt voltmeters, Cardew voltmeter, Queen magnetic vane voltmeter, Hartman and Braun gravity voltmeter, etc. For measurement of power, Thomson's wattmeter and Prony brakes. For engine tests, Tabor and straight line steam engine indicators.

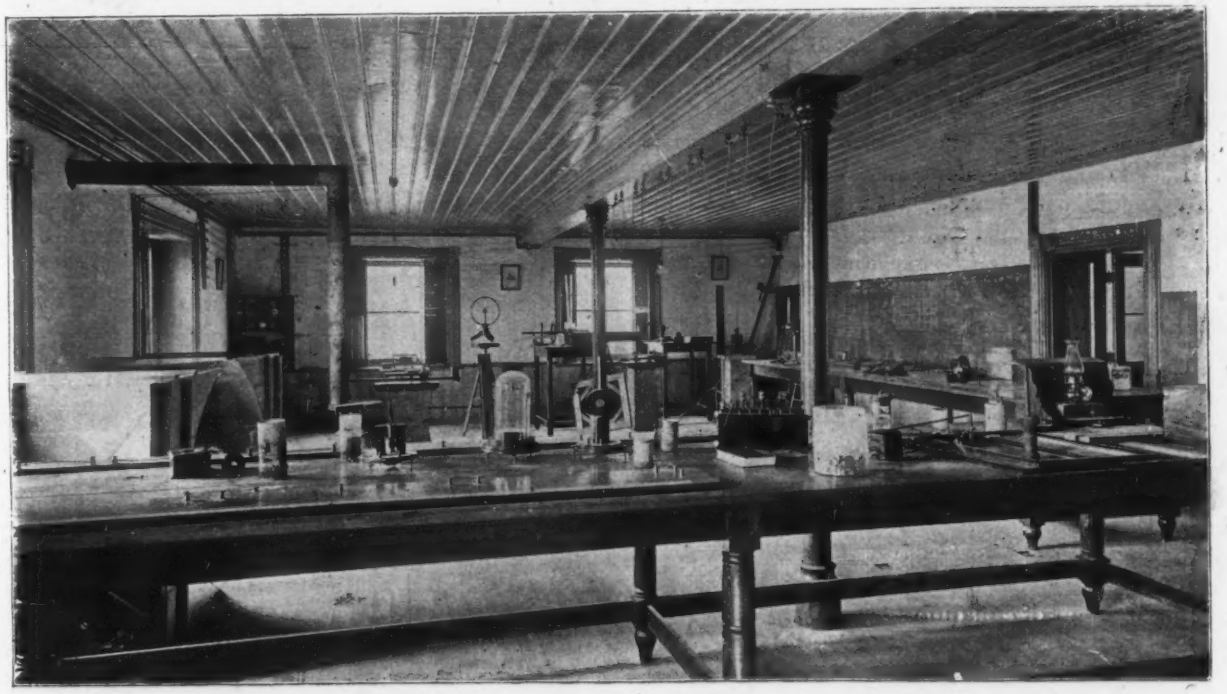


FIG. 2.—A VIEW IN THE ELECTRICAL LABORATORY.

Fig. 1 shows an external view of the electric station, which has just been completed and equipped. Fig. 3 shows the interior of the same. The engines used are a 25-h. p. Atlas automatic, 225 revolutions per minute, and a Westinghouse 35-h. p. Junior, 350 revolutions per minute. These engines are belted to a 2 15-16-inch shafting, joined in the middle by a clutch coupling. The dynamos installed are a 12-kw. Edison compound, 125 volts, 94 amperes; a Weston shunt dynamo, 150 volts, 25 amperes; a Thomson-Houston motor of 10 h. p., which is used also as a dynamo; a Brush 6-light arc machine with lamps; a Crocker-Wheeler 1-h. p. motor, also used as a dynamo; a 400-volt, 20-ampere generator, and a 2-phase alternator, made by students.

This 400-volt generator furnishes current to the 10-h. p. motor (also built by students) at the experiment station farm. This motor operates a cotton gin and screw press, an ensilage cutter, a thresher, corn sheller, cottonseed crusher and a grinding machine. This plant has been in operation since April, 1892. This motor replaced a 15-h. p. engine, furnished with steam from a 15-h. p. boiler. A 125-volt motor, operated by the Edison generator at the college, was first installed. Last spring the system was changed from a 125-volt to a 400-volt with increased efficiency. This plant affords the student a practical example of the electrical transmission of power.

Fig. 2 shows a view of the electrical laboratory.

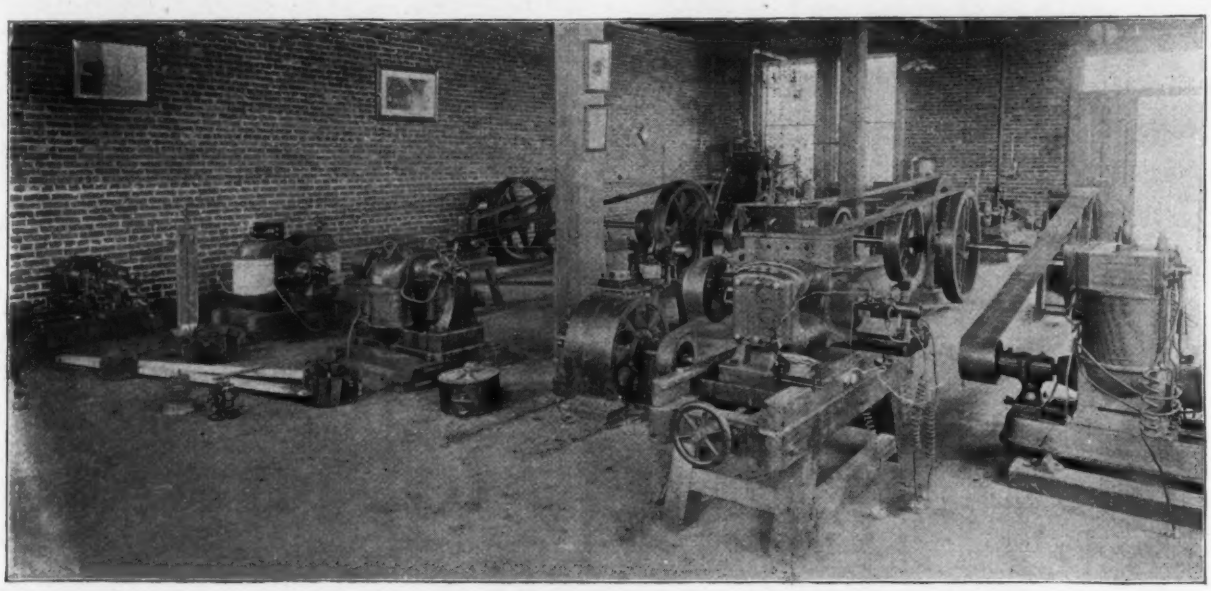


FIG. 3. INTERIOR OF POWER STATION.

The Calculation of Alternating Current Motors—IX.

BY E. ARNOLD.

DETERMINATION OF THE SHIFTING OF PHASE Φ_1 AND THE EFFICIENCY.

From Fig. 19 it follows that

$$\cos \Phi_1 = \frac{I_1}{E_1}\left(R_1 + \frac{m\, s_2}{4}\,\frac{p_1\,(p_1 - p_2)\,M\,R_2}{r^2}\right). \quad (103)$$

By the employment of equation (73) we have

$$\cos \Phi_1 = \frac{r}{\sqrt{N}}\left(R_1 + \frac{m\, s_2}{4}\,\frac{p_1\,(p_1 - p_2)\,M^2\,R_2}{r^2}\right).$$

For small values of R_1, L_2 and $(p_1 - p_2)$ we can place approximately

$$\cos \Phi_1 = {}^1/_2\, b^2\, s_2\, p_1\, v\,\frac{L_2}{R_2}. \quad (104)$$

From equations (97) and (102) there results

$$\cos \Phi_1 = \frac{b^2\, I_\omega}{\sqrt{I_0^2 + I^2{}_\omega}}. \quad (104\,a)$$

The last equation shows that the shifting of phase depends upon three quantities—the exciting current, the useful current and the leakage.

Cos Φ_1 grows with the load current, and therefore with increasing slip v. But when v grows, the efficiency of the motor falls (vide equation (109)). As the amount of slip is consequently limited to small values, the exciting current must be kept weak in order to preserve as small a phase-shifting as possible, and the greatest stress must be laid upon the lessening of the leakage.

The watts consumed by the motor are

$$W_t = \frac{m}{2}\, E_1\, I_1 \cos \Phi_1,$$

or

$$W_t = \frac{m^2}{2}\, R_1\, I_1^2 + \frac{m^2\, s_2}{8}\,\frac{p_1\,(p_1 - p_2) M I_1^2\, R_2}{r^2} \quad (105)$$

The watts lost through hysteresis and Foucault currents are taken into consideration by a corresponding increase in the resistances R_1 and R_2.

The second term of the second member of equation (105) gives the sum of the watt output of the motor and the watts consumed by the armature.

The first part is

$$W = \frac{m^2\, s_2}{8}\,\frac{p_2\,(p_1 - p_2)\,M^2\, I_1^2\, R_2}{r^2}; \quad (106)$$

the second part is

$$W_s = \frac{m^2\, s_2}{8}\,\frac{(p_1 - p_2)^2\, M^2\, I_1^2\, R_2}{r^2}. \quad (107)$$

Disregarding the friction losses W_h, the efficiency of the motor is

$$\eta = \frac{W}{W_t}$$

$$= \frac{m^2\, s_2\, p_2\,(p_1 - p_2)\, M^2\, I_1^2\, R_2}{4\, m\, R_1\, I_1^2\, r^2 + m^2\, s_2\, p_1\,(p_1 - p_2)\, M^2\, I_1^2\, R_2}, \quad (108)$$

or, approximately,

$$\eta = \frac{p_2}{p_1} = 1 - v. \quad (109)$$

This efficiency is reached with a closeness of from 2 to 5 per cent.; with larger motors, from about 10 h. p. upwards. The choice of the slip v is, therefore, essential in determining the efficiency of the motor.

THE CONSTRUCTION OF THE FIELD AND THE ARMATURE.

The winding of the field and the armature can be carried out as ring, drum and pole winding. For motors with high primary potential, ring winding and pole winding are of advantage in having no crossing of the wires, but, on the

other hand, ring winding has the advantage of greater leakage. For larger motors and low primary potential drum winding with rods can be so arranged that the cross connections are carried out in two planes, whereby good insulation is made possible and a small leakage is attained.

The magnetic qualities of the field are calculated as with transformers. The induction of the former is

$$B_1 = \frac{\overline{E_1}\ 10^8}{4.44\ F_1\ N_1\ n_1}. \qquad (110)$$

The induction in the armature iron is

$$B_2 = \frac{b\ E_1\ 10^8}{4.44\ F_2\ N_1\ n_1}. \qquad (111)$$

Under the assumption that all the lines of force unite to

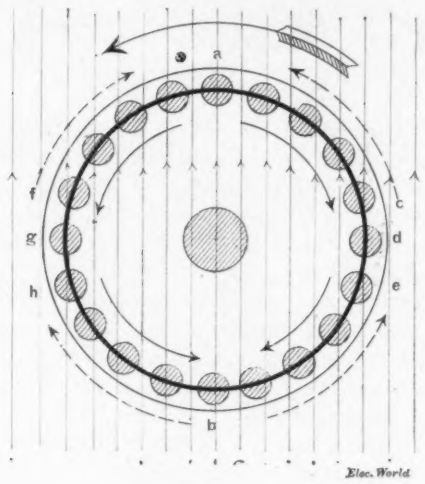


FIG. 20.

form a rotary field, the number of periods for the armature iron is only $= p_1 - p_2$, and the magnetic qualities of the latter can therefore be taken greater than for the iron of the magnetic field.

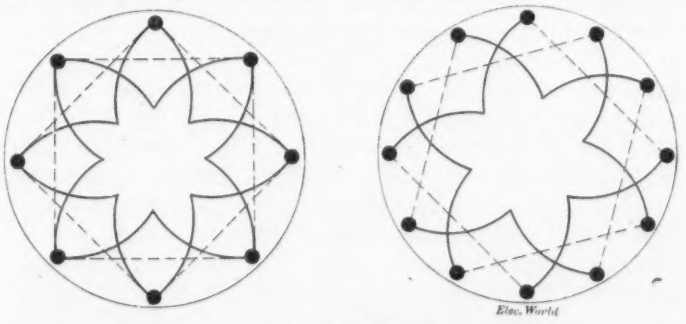
The closed circuited winding of the armature can likewise be carried out as drum, ring or pole winding, and each, indeed, in three different ways:

(1) The whole of the copper rods on every side of the armature are short circuited among themselves. (According to Dobrowolski.)

(2) All those rods on every side of the armature which are acted upon inductively in the same, or nearly the same, manner are short circuited among themselves.

(3) All those rods which are acted upon inductively in the same, or nearly the same, manner are connected in series and short circuited.

The first method of construction has the advantage of great simplicity, but several disadvantages are associated



FIGS. 21 AND 22.

with it. For larger outputs it is not possible to preserve a sufficient cooling surface with one short circuited ring, not even when the latter is in the form of a band, and then the induced currents partly take such a course that the secondary rotary field is weakened and the attractive power of the motor is lessened. In Fig. 20 the front view of such a closed circuited armature is shown. Let us imagine the armature at rest and the magnetic field rotating in the direction of the upper arrow. The induced currents in the front short-circuited ring take a course indicated by the inner arrows, and those in the back ring a direction shown by the outer dotted arrows. The rods *c*, *d*, *e* and *f*, *g*, *h* experience no induction at the given moment, but in spite of this part of the current will find its way through these rods and weaken the secondary rotary field.

For these reasons I give the preference for those constructions proposed under (2) and (3).

In Figs. 21 and 22 are shown the diagrams of connections for a four-pole motor constructed according to the second and third methods, respectively.

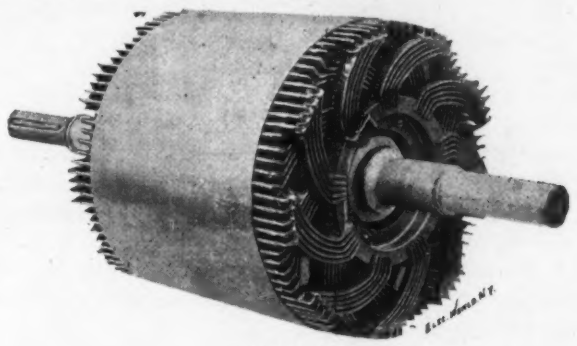


FIG. 23.

Fig. 23 gives a view of an armature constructed according to the third method by the Maschinenfabrik Oerlikon.

Letting R_0 represent the resistance of *one* armature rod, *including* the resistance of the cross connection, which goes with this rod, it follows from equation (91) that

$$R_0 = b^2 \frac{s_2}{W} \frac{N_2}{N_1^2} E_1^2\ v\ (1 - v).$$

Now $s_2\ N_2 = Z$, the total number of rods in the armature, and from this there follows the equation, good for all three constructions of the armature,

$$R_0 = b^2 \frac{Z\ \overline{E_1}^2}{W\ N_1^2}\ v\ (1 - v), \qquad (112)$$

and the watt output is

$$W = b^2 \frac{Z\ E_1^2}{R_0\ N_1^2}\ v\ (1 - v). \qquad (113)$$

(To be continued.)

Recording Voltmeters.

We have received a communication from Mr. E. J. Richards, superintendent of the Belt Electric Line Company, Lexington, Ky., giving an account of the excellent results which he has obtained through the use of recording voltmeters. In Mr. Richards' station they operate about 7,000 incandescent lights of the alternating system, and as a matter of experiment a couple of recording voltmeters were put in about five months ago. The first charts taken showed that the pressure during the 24 hours varied anywhere from 49 to 56 or 57 volts. As a consequence, the dynamo men were instructed in regard to the matter of watching their pressure more closely, and knowing that any delinquency would be detected through the record left by the instruments, the improvement has been very great, some recent cards showing a very slight variation during the 24 hours. One of the instruments is located at the centre of distribution of one of the feeders, 1 1-4 miles from the station. From the good results he has derived from the use of these instruments, Mr. Richards is convinced that they are as necessary to a well equipped station as recording steam gauges, and states that the recording voltmeters which he has now in the station have paid for themselves in the past three months in the reduced number of lamp renewals.

THE ELECTRICAL WORLD'S DIGEST

OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS BY CARL HERING.

ELEC WORLD, N.Y.

ELECTRO-PHYSICS.

Alternating Currents in Parallel.—In the Lond. "Elec. Rev.," April 13, Mr. Rimington gives a graphical treatment of the problem of alternating current conductors in parallel; in a previous paper (see Digest, Jan. 13) he gave a graphical method of finding the apparent impedance of the primary of a transformer; in the present article he discusses the case of impedance in parallel.

Adiathermanous Glass.—The Lond. "Elec.," April 13, contains a short article and an editorial on this subject; the article gives the comparisons between a large number of substances.

Electricity of Drops.—The "Elek. Zeit.," March 15, abstracts an article by Mr. Wesendock from the "Wied. Ann.," volume LI., page 353.

MAGNETISM.

Magnetic Qualities of Iron.—The paper of Prof. Ewing and Miss Klaassen is continued in the Lond. "Elec.," April 13, including a large number of curves. This paper is doubtless one of the most important of those recently published on hysteresis and should be read in its entirety. Among other things they show that the result of special annealing after a wire ring is coiled was to make the stages of the cyclic process much more sharply differentiated than before, the curves being now exceedingly square shouldered; but the work lost in hysteresis was not reduced by the annealing; they believe that there is "a doubt whether all that is possible has yet been done by manufacturers of iron to produce a quality specially suitable for such uses as the construction of transformer cores. The conditions of manufacture which secure low hysteresis appear to be imperfectly known, or at least to be less generally recognized than electricians might wish." Some of the figures show in a striking way the extent to which the dissipation of energy in hysteresis may vary in different specimens, even of soft iron; high maximum permeability does not necessarily imply small hysteresis losses, a statement which is borne out by a number of their curves; the easy slope of some of the soft iron curves allows them to be crossed by curves for steel, even under moderate magnetizing forces; with a magnetizing force of 13, for instance, more magnetism will be produced in a rather hard steel specimen than in a very soft iron one; a comparison of permeabilities in this respect with any such force would furnish no criterion of magnetic softness; specimens, however, which are soft in a sense of having small hysteresis losses excel in permeability in the initial stage of magnetizing process. They made a critical examination of Mr. Steinmetz's formula, in which the hysteresis loss is equal to a coefficient multiplied by B to the 1.6th power; within a certain range of values of B this formula may be taken as giving a fairly close approximation to the real values; from $B = 2{,}000$ to 8,000, which includes the values generally used in transformer cores, they found for a certain thin sheet iron ring that the coefficient was 0.01 and the exponent 1.475; from $B = 8{,}000$ to $14{,}000$ the coefficient is 0.00134 and the exponent 1.70; from 200 to 500 the exponent is 1.9; from 500 to 1,000 the exponent is 1.68, and from 1,000 to 2,000 it is 1.55; they conclude that no formula of that type with a constant index will represent the results within anything like the limits of experimental accuracy; the index begins with 2 degrees, is about 1.47 in the region of high permeability and then increases again to 1.7 when the turning point has been passed; while a formula of this type cannot be admitted to have any physical significance, it may still be serviceable in approximate calculations for the purpose of the electrical engineer; several tables of observed and calculated values are given; if the observed and the calculated curves are to coincide throughout in a short path, other and very different values must be given to the coefficient and the index. Editorially it is stated that this is the most important contribution to our knowledge of the actual material used by transformer makers that has yet been published.

Magnet for Very Intense Fields.—The "Elec. Zeit.," April 5, abstracts an article by Mr. De Bois from the "Wied. Ann.," volume LI., page 537, by means of which field intensities of 38,000 C. G. S. units (gausses) can be generated; unfortunately, no illustration is given, but the magnet has the form of a ring.

Designing Magnets.—See article by Mr. Marcher under "Dynamos."

UNITS, MEASUREMENTS AND INSTRUMENTS.

Astatic Station Voltmeter.—In an Institution paper by Professor Ayrton and Mr. Mather, to be published in the Lond. "Elec. Eng.," and possibly in other journals also, they lay down the following conditions which should be filled by such an instrument: It should be unaffected by outside fields whether uniform or not, it should be unaffected by outside electrostatic disturbances such as those produced by cleaning the glass, it should have no temperature error, it should have a high resistance so as to measure equally well the true voltage at the end of long pilot lines or at the station itself, it should have a scale of large radius and a very open one at the working voltage, it should be dead beat. The first condition is fulfilled by using powerful stationary permanent magnets and a moving coil; it has been found from experiments that fields of 20 C. G. S. units (gausses), or equal to more than 100 times that of the earth, occasionally occur on switchboards of existing stations, while fields of six units are quite common; if the coil is wound astatically and acted on by two magnets it will be screened from a uniform field but not from a non-uniform one, such as that from a neighboring conductor; for this reason they use three

permanent magnets and a coil wound in three parts, the area of the middle coil being double that of the end one; the resistance of a 100 volt instrument is about 7,000 ohms, of which only 3 per cent. is composed of copper wire, the rest being manganin wire, the temperature error being therefore practically negligible and the consumption of energy is only 1.5 watts for 100 volts; the counter-action is produced by gravity; the current leads are made of very thin flexible silver strips; the open scale of 100 volts, as also the dead beatedness, are obtained by shaping the air-gap; at 100 volts the one-hundredth part of a volt can be detected; the normal position of the pointer is indicated by an index which can be set to any desired point and is colored red while the arrow head pointer is colored black, and they are in such a position that when pointing correctly the red is covered by the black pointer, whereas if the voltage varies the red will show to the right or left of the pointer; the inside of the glass cover is coated with a layer of their transparent conducting varnish, described in the following paragraph.

Measuring the Insulation of Lines While in Use.—In an article by Dr. Froelich, mentioned in the Digest March 18, last year, he describes a method, which, however, requires the use of a calibrated galvanometer or voltmeter; in the issue of the "Elek. Zeit.," April 5, he describes a modification of this method, in which an ordinary galvanoscope can be used, that is, one which indicates a current without measuring it; the theory is given, which is best understood when read in connection with the former article.

Nomenclature and Symbols.—A long editorial in the Lond. "Elec.," April 13, discusses unfavorably the new names proposed for the magnetic units; it questions the need of a unit of magnetomotive force, which it claims is a clumsy analogical comparison to the expression electromotive force; it thinks that confusion is likely to arise if the factor 4π is to be suppressed; it is thought that the term, number of lines, is quite sufficient for all practical purposes, and that the unit gauss can be dispensed with. The block or Gothic letters for the magnetic units are preferred to the pen type letters recommended by the congress.

Meters.—In a paper by Mr. Wilson, reprinted in the Lond. "Elec. Eng.," April 13, he gives illustrated descriptions of the Aron and Thomson-Houston meters, without, however, giving anything new.

Electrodynamometer.—The "Elek. Zeit," March 15, abstracts a description from "Wied. Ann." of an instrument intended specially for electro-therapeutical purposes.

Pocket Galvanometer.—An instrument made by Siemens & Halske is described and illustrated in the "Elek. Zeit.," April 5.

Testing Iron.—A paragraph on this subject will be found on page 596.

DYNAMOS AND MOTORS.

The Sayers System of Winding Armatures.—The Lond. "Elec. Eng.," April 13, reprints a paper by Mr. Mavor, in which he describes in detail the Sayers system, described in these columns last year; the present description is much more complete and clear than those previously published; he also shows a modified arrangement which will enable the dynamo to be run in either direction, the previously described arrangement being for one direction only; the connection of the commutator coil is exactly the same, but has two sides, an active and an idle side, the active side being that under the pole tip when the coil is connected to the brush.

Alternating and Multiphase Currents from Continuous Current Armatures.—The conclusion of Mr. Friese's article, abstracted in the Digest March 17 and April 7, is contained in the "Elek. Zeit.," March 15. He gives similar figures for 6, 8 and 12 phase currents and concludes with the development of general formulas.

Leakage Coefficient.—Mr. Mavor in the Lond. "Elec. Eng.," April 13, states that the ratio of the total field to the useful field of dynamos of ordinary design varies from 1.2 to as much as 2.0.

TRANSFORMERS.

Three-phase Transformer.—The transformer used at the Jura-Simplon workshops is illustrated and described briefly in the Lond. "Elec. Rev.," April 13; the primary and secondary are wound on three vertical laminated cores, united at the top and bottom by laminated circular discs, each core containing a primary and secondary; comparing this construction with three separate closed circuit transformers it was found that the weights are as 3 to 4 in favor of the three-phase transformer.

ARC AND INCANDESCENT LIGHTS.

Cored Carbon Litigation.—The "Elek. Zeit.," March 15, contains another lengthy communication on this subject.

TRANSMISSION OF POWER.

Series Transmission of Power.—A translation of Mr. Schultz' article, mentioned in the Digest April 14, is given in abstract in the Lond. "Elec.," April 13.

ELECTRIC RAILWAYS.

Overhead Contact Arrangement of the Genoa Railway.—A brief illustrated description is given in the Lond. "Elec. Eng.," April 13; instead of the trolley wheel there are two trolley arms with a long cross-bar at the top, forming, with the trolley arm, a device shaped like the letter T, the length of the upper part being almost equal to the width of the car; the upper part is made of a special metal and is easily renewable; it presses against the under side of the overhead conductor and one of the chief advantages is that much of the overhead straining or pull-off wires are rendered unnecessary at curves, since the trolley wire need not follow the rounded curve of the rails; the main object is to prevent the continual jumping away of the trolley wheel from the line.

Alternate Current Railway System.—At the Lyons Exhibition the Creusot works will exhibit the Lombard-Gerien overhead conductor system, using alternating currents of high potential in connection with transformers. The Fives-Lille Company will exhibit a railway using polyphase currents, which will be run experimentally only and will carry no passengers.

Electric Traction on London Railways.—In an article by Mr. Lea, in the Lond. "Elec. Eng.," April 13, he discusses the practicability of utilizing electric traction on the London City railways, which at present use steam power; the principal question involved is whether both steam and electric trains could be run, because some of the District railway trains in the underground railway run from suburban lines directly into the underground lines. The paper is entirely of local interest.

An article reprinted in the Lond. "Elec. Eng.," April 13, gives the itemized train mileage expenses for the City and South London line and those for the underground steam lines in parallel columns.

Heilmann Locomotive.—According to the Paris "Figaro," the Heilmann locomotive is to run regularly betwen Mantes and Paris, a distance (the length of which is not given) which will be run in 50 minutes. It is also stated that a second similar locomotive is under construction to develop 1,200 to 1,500 h. p.

Electric Locomotive.—The Lond. "Elec.," April 13, states that the Bernese Oberland Railway Company is contemplating the substitution of electric traction for steam, the scheme comprising 200-h. p. locomotives, with 10 trains on the line simultaneously, water power being used as the source.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Two-phase vs. Three-phase Currents.—In his serial in the Lond. "Elec.," April 13, on electromotive power, Mr. Snell discusses the relative merits of these two currents. Machines designed for similar outputs, whether synchronous or non-synchronous, are found to have about the same efficiency, starting torque and apparent watt consumption, the three phase, however, being the better, according to the engineer of the Oerlikon Works; for the simple transmission of power between two distant points a three-phase current system is generally cheaper than either a continuous, a one or a two-phase alternate current system; the main difference between the two systems lies in the relative weights of copper for the conductors and the ease with which the currents may be handled; he discusses this at some length from three points of view on the basis of effective pressure at the distributing station, on the basis of maximum difference of voltage and when the economic law is considered; the ratios of the weights of copper under these conditions are given in a large table; he concludes that as regards the prime cost of line the three-phase system is cheaper for long transmission than the single or double phase; continuous currents are the cheapest of all, but are not admissible for extra high voltages.

Leveling the Load Line.—According to the Lond. "Elec.," April 13, it has been recommended that the power developed at the station at Worcester should be utilized at the water works in place of steam, thus supplying work for the station during the daytime; the recommendation is heartily commended as a very practical one.

Fusible Cut-Outs.—A translation of the first part of the article by Mr. Anney, mentioned in the Digest March 31 and April 14, is published in the Lond. "Elec. Rev.," April 13, under the heading of "Present Conditions of Installing Electric Mains in the Premises of Consumers Supplied from Central Stations."

Aix-la-Chapelle.—In the "Elek. Zeit.," March 15, Mr. Uppenborn gives a well illustrated description of this station, in which a three-wire direct current system is used with accumulators. The present description forms the fifteenth and last of the series described in this journal, and mentioned in the paragraph below.

Germany.—A list of the 15 stations which were very fully described and illustrated in the "Elek. Zeit.," is given, together with the reference numbers, in the issue of March 15; the list comprises the largest stations in Germany and adjoining countries, the illustrations having been, as a rule, large, well selected and executed.

Hanover.—Detailed statements of the output, accounts and other like data regarding this station are given in tabular form, in the "Elek. Zeit.," March 15.

Livet's Destructor.—The Lond. "Elec. Rev.," April 13, contains a long editorial and letter on this apparatus.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Individual Telephone Call.—In the "Elek. Zeit." April 5, Mr. Kohlfuerst describes the Reiner apparatus which is used in Munich, in which a number of subscribers are connected in series on a single line and in which each can be called individually; an apparatus for ten subscribers is described, a cut being given of all the connections. To call a station the required number of impulses for that station are sent to line; they are received by all the subscribers, but only the one set for this number of impulses will be operated by the subsequent negative impulse which operates the bell by means of a polarized relay.

Induction Telephony.—The Lond. "Elec. Rev.," April 13, mentions an experiment of Mr. Stevenson, in which communication was established between the mainland and a lighthouse by means of an induction system; the apparatus is not described, but it is stated that two coils 200 yards in diameter of nine turns each of ordinary telegraph wire were erected on poles 800 yards apart; the coils were not earthed; messages could be sent with 10 cells with perfect ease, and even with only five; the experiments are said to have been entirely successful.

Railroad Signals.—The Perls system for single track lines is briefly described in the "Elek. Zeit.," April 5.

MISCELLANEOUS.

Infantile Paralysis.—The Lond. "Elec. Rev.," April 13, contains a letter by Mr. Hedley from the "Lancet," on the electrical treatment, in reply to a recently published paper.

The Lighting of the Grand Central Station, New York City.

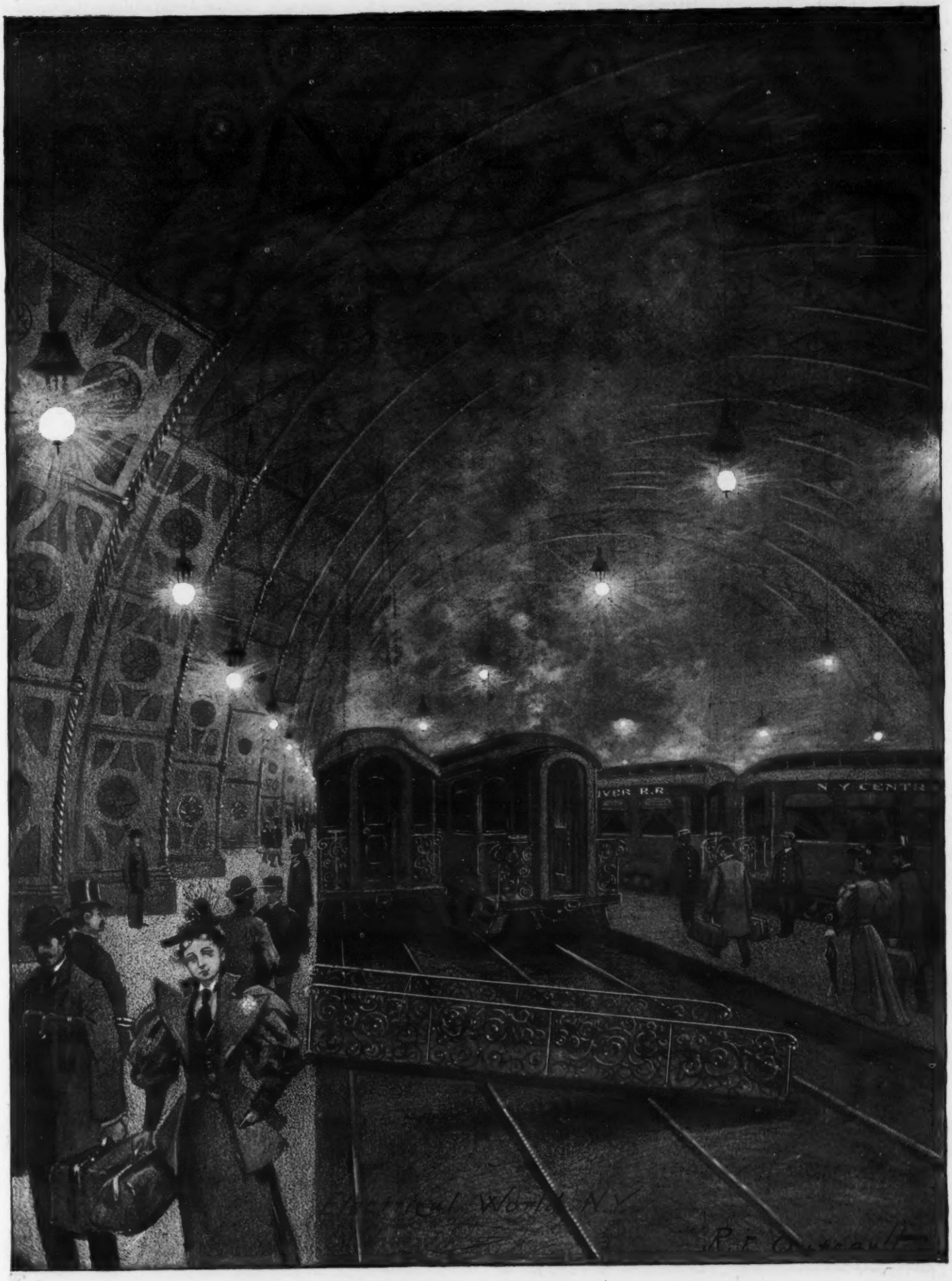
One of the best illustrations of interior lighting by the use of arc lamps is the Grand Central Station in New York City. The possibilities of interior illumination by the employment of arc lamps on incandescent circuits are now being generally recognized, as this instance shows, They have been found to give excellent results in theatres, halls, and other large interiors, but they have seldom been applied to the lighting of such great areas as has been done in this case.

The interest in this installation, however, centres in the fact that it was the first time that arc lights were commercially used with success on incandescent circuits, and for that reason the plant will continue to attract considerable attention. Prior to August, 1890, this immense structure was lighted by some 1,400 incandescent lamps. During that month, however, a few Ward arc lamps were introduced as an experiment, and the result proving an entire success, they gradually supplanted the incandescent lamps, until to-day the entire area of the ground floor, including the incoming and outgoing train sheds, waiting rooms, ticket offices, etc., is brilliantly illuminated by about 90 arc lamps, this being the number required to more than take the place of the 1,400 incandescents previously employed. The accompanying illustration gives a view of the station brilliantly illuminated at night.

The type of lamp used is the well known arc lamp manufactured by the Electric Construction and Supply Company, Telephone Building, New York City. The lamps are placed two in series on a 110-volt circuit. Current is furnished by an isolated Edison plant in the building. In the incoming station and baggage room, the dimensions of which are 600 by 130 feet, are placed ten lamps, while over the tracks in the outgoing depot fourteen are used. Six more are located in the ladies' waiting room, vestibules, etc., and two in the elevated railroad station, which forms a part of the incoming station. The outgoing station is 600 feet long and 225 feet wide, and this immense area of 135,000 square feet is brilliantly lighted by 32 Ward lamps, which took the place of 500 incandescents. In the station of the Harlem road four Ward lamps replaced 36 incandescents, while in the New York Central 67 incandescents were replaced by six Ward arcs. The rest of the lamps are scattered through the building in various places.

The 1,400 incandescent lamps with which the station was previously lighted consumed 700 amperes, while the 90 arc lamps require but 360, and at the same time illuminate the building five or six times as well.

This system of interior lighting has proved most satisfactory to the railroad authorities, combining, as it does, the convenience and flexibility of incandescent lighting with the brilliancy of the arc. The success of such a plant is dependent in a measure upon the care it receives and the good results obtained in this case are due in a considerable degree to the excellent supervision of Mr. E. L. Pollard, the electrician of the Grand Central Depot.



ILLUMINATION OF THE GRAND CENTRAL DEPOT, NEW YORK CITY.

New Book.

TRAITE DE TELEGRAPHIE ELECTRIQUE. By H. Thomas, Ingenieur des Telegraphs. Paris, Libraire Polytechnique, Baudry et Cie. 1894. 901 pages, 702 illustrations. Price $7.50.

In this book we unquestionably have a work of much merit, and one that cannot fail to be of great value not only to those for whom it has been especially written—the employes of the post-office telegraph service of France—but also to others who may be interested in the principal methods employed in that enterprising country in the operation of its telegraph service.

While, as the author points out in his preface, the systems at present employed in France are described in great detail, yet he has not confined himself to these alone, for there is also to be found described at some length within the covers of this valuable work the chief automatic system employed by the British post-office department, namely, the Wheatstone automatic telegraph. He has also passed in review many of the early systems of telegraphy employed in France and elsewhere, and has also found space to describe a number of systems, which, in this and other countries, have been tried and laid aside, such as Gray's harmonic telegraph and several others.

The book is written in a very lucid manner, and to facilitate the descriptions, illustrations to the number of 702, of a high degree of excellence, have been furnished, and it seems quite apparent that the great bulk of these illustrations have been expressly prepared for this work.

As was to be expected, the Baudot synchronous telegraph system, which is in extensive use in France, has received very full attention, and no pains have been spared by the author to explain this system to the minutest detail. The Hughes printing telegraph system has also received generous treatment, and it certainly will not be the fault of the author if any one familiar with the French language should hereafter remain in ignorance of the style of apparatus and mode of operation of either of these systems. The simple Morse system—open circuit method—which is in operation in France between points where the volume of business would not warrant the employment of the Hughes or Baudot systems, is also fully and clearly described.

Somewhat singularly, perhaps, the quadruplex system, which is in such extensive operation in this country, and somewhat extensively in Great Britain, is dismissed in one or two pages by M. Thomas, while Gray's telautograph, which is not in very extended practical use, if at all, is allotted several pages. This is not, however, intended as adverse criticism, as it is doubtless within the author's right to treat those systems which are not in operation in his own country according to his own notions of propriety.

An interesting chapter is deservedly given to the description of the telephone, more especially in its relation to simultaneous telegraphy and telephony, and in the course of this chapter many of the best known receivers and transmitters are shown and described.

A chapter is also devoted to a description of various forms of primary batteries; another to testing apparatus and testing, and another to the localization of faults on telegraph lines, etc. Among the testing apparatus described is the Thomson electrometer. This description could, perhaps, have been relegated to books more exclusively relating to testing, since it is an instrument rarely used by ordinary telegraphers in testing, and, indeed, requires such careful manipulation in the majority of cases as to be beyond the skill of any but the more expert electricians to handle. This, however, illustrates the completeness with which the author has performed his self-set task, and adds to the value of the book as a work of reference.

Telegraph construction, aerial, underground and submarine, has also received thorough treatment at the hands of the author, the plan followed being, as a rule, that most commonly adopted by writers on telegraph engineering, the formulae for tension, sag, etc., of wires, and for the angle of curve of conduits, etc., being given at full length. The space allotted to the laying and repairing of submarine cables is well employed. The author also pays considerable attention to many of the laws of electricity concerned in telegraphy, a chapter, for example, being devoted to "the propagation of the electric current in a telegraph line," in which the variable state of the current, the duration of the variable state, the effect of self-induction of conductors, etc., are discussed with the aid of numerous graphic illustrations, the latter being a method frequently and advantageously adopted throughout this work.

While the book as a whole is quite elementary in its treatment of its different subjects, yet recourse is had quite frequently to mathematics, whenever the author has deemed this method advisable. To some readers it may seem that he has adopted this plan of treatment at greater length than is essential, but as in the majority of cases these mathematical explanations are placed in footnotes and in smaller type than usual, and are, generally speaking, merely additional explanations, they may without serious detriment be omitted by the non-mathematical reader. When it is considered that the volume under consideration contains 21 chapters and 901 pages, it will readily be perceived that the foregoing remarks touch upon but a small fraction of the subjects discussed therein.

In view of the extent of the work the typographical errors are remarkably few, and much credit is certainly due the enterprising publishers for the excellent appearance of the type, engravings and press work.

Three-Phased Power Transmission.

The first important application of electrical power transmission to textile manufacture has just been installed by the General Electric Company at Taftville, Conn., the power being transmitted from Baltic to Taftville, a distance of nearly 4 1-2 miles. It is a typical transmission by three-phase currents, in which motors of the synchronous type are used not only to operate one of the largest cotton mills in this country, but also the power station of the Norwich, Conn., Street Railway.

In the basement of the Baltic mill, on the Shetuget River, are the wheel and dynamo rooms of the generating plant. The mill is of four stories, built of stone, and will presently be used, as are the Ponemah mills at Taftville, in the cotton weaving industry. Four hundred feet above the mill a fine stone dam 525 feet long has been thrown across the river. The effective head on the turbines is 32 feet, and the water available, even in the driest seasons, is sufficient to furnish not less than 1,500 h. p.

Fig. 1 is a plan of the basement of the mill, in which the power plant is located. It will be seen that the turbines are belted to pulleys on the main line shaft, extending the whole length of the wheel room and continuing through the partition walls into and along one side of the generator room. The pulleys are thrown into, or out of, action by Hunter clutches mounted with pulleys on quills, so that any or all of the wheels can be applied to driving the shafts. Similar pulleys and clutches are furnished in the dynamo rooms for throwing in or out the various machines that may there be placed.

In the wheel room are three double 42-inch horizontal turbines and one double 27-inch turbine, the former developing 800 effective horse power each, at 157 revolutions per minute, and the latter 300 h. p. at 244 revolutions per minute. The belts pass obliquely upward to the pulleys on

the line shaft, and the turbines are kept at speed by Schenck electric governors, which have proved themselves capable of doing very fair service. The wheel plant and shafting were made and installed by the P. C. Home Company, of Gardiner, Me. The line shafting is supported by heavy iron girders set on stone piers and additionally braced by timbers.

In the dynamo room are two 250-kw. General Electric three-phase generators, delivering current to the line at 2,500 volts. Each machine is provided with its own exciter, a

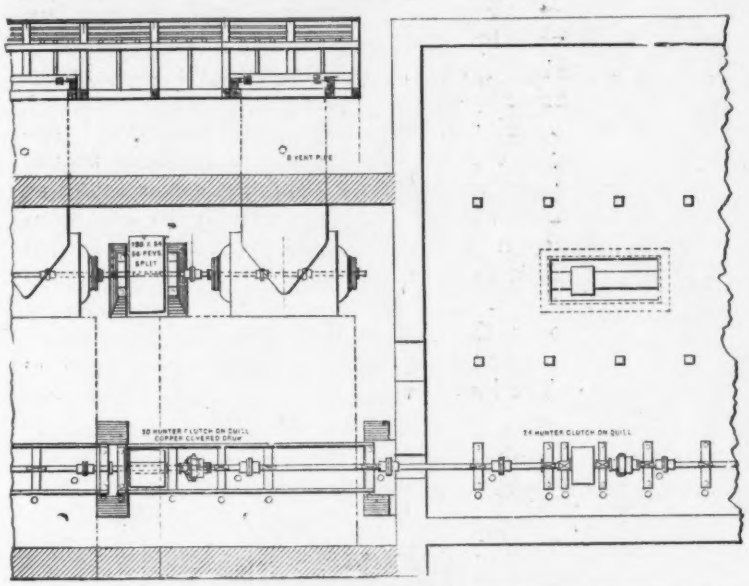


FIG. 1. PLAN OF POWER PLANT IN BASEMENT OF MILL.

3-kw. bipolar dynamo. The three-phase machines run at 600 revolutions per minute, and are set so firmly on substantial foundations as to run with scarcely a perceptible vibration. The driving pulleys on the main shaft are fitted with Hunter clutches, so that either machine can be dropped out without the slightest disturbance to the service.

The generators are connected to a common switchboard, Fig. 2, and may be run in parallel whenever desirable. To this end the board is furnished with synchronizing apparatus, the acoustic synchronizer being mounted on the face of the switchboard, and the equalizing switch being at the back. The most interesting novelties on this switchboard are the high voltage switches on the lower part of the board. These are mounted on marble bases with substantial barriers erected between the switch blades, so that the circuit at full load and voltage may be broken without the slightest danger of arcing across from point to point. They have been amply tested and have proved their ability to cope with the trying work required of them with the greatest ease. The generators fall into parallel easily and run as smoothly together as would a couple of railway generators. No artificial load is used in throwing them together, none having proved necessary.

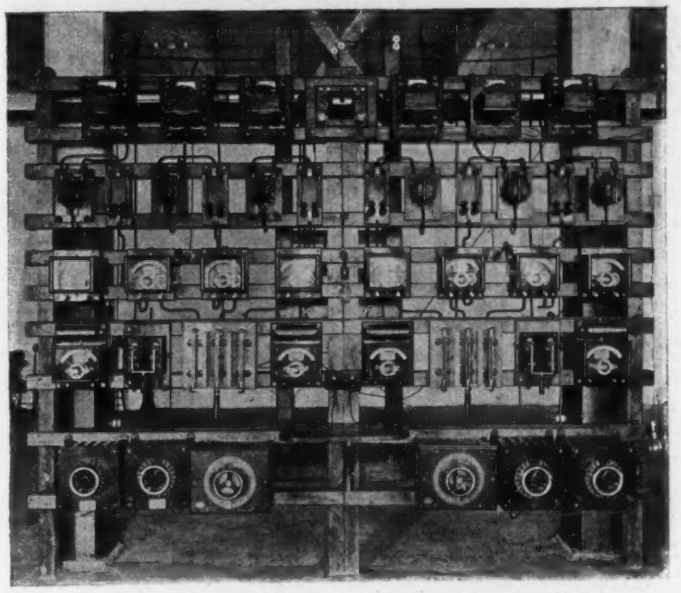
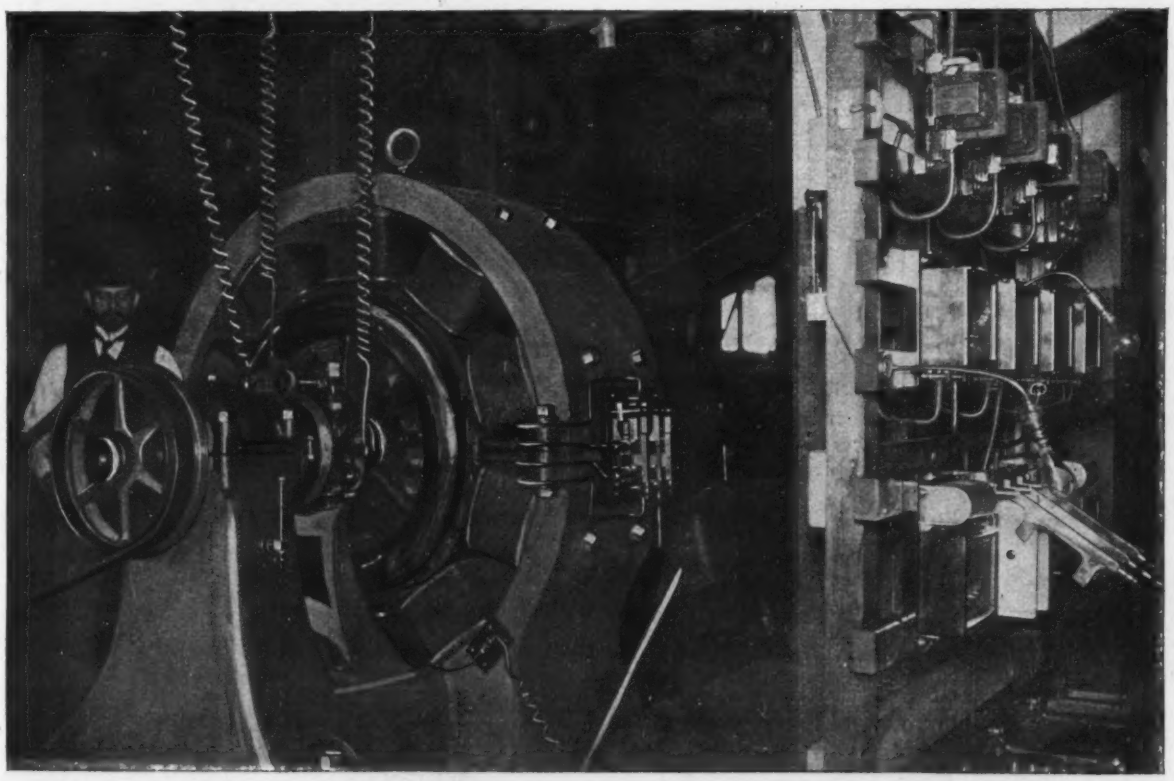


FIG. 2. THE MAIN SWITCHBOARD.



SYNCHRONOUS MOTOR AND ITS SWITCHBOARD.

The line is on substantial wooden poles, placed 100 feet

apart. There are two cross-arms, the wires on the upper one being of No. 0 bare copper and form the original three-phase circuit designed for the transmission. The wires on the lower cross-arm are No. 0000 insulated wire, and are four in number. They were originally intended for a railway circuit, the generators for which were to be installed at Baltic to feed the Norwich Street Railway; but as the amount of copper necessary to do the work successfully appeared too great, the system was changed, a second three-phase generator and motor were added, and three of the four proposed feeder wires were utilized for the three-phase circuit. All are supported on the General Electric Company's standard oil insulator, the fourth No. 0000 wire forming a convenient relay in case of accident to any of the others.

At Taftville the three-phase circuits are led into the basement of the new mill, where they drive two three-phase synchronous self-starting motors, Fig. 3, identical in size with the generators at Baltic. These machines replace the two Corliss engines of 350 h. p. previously used. One motor, with its switchboard, is shown in Fig. 3, which also gives an excellent view of the high voltage switch before referred to. These motors are belted to the jack shafting previously driven by the engine, the pulleys on the shaft being equipped with friction clutches so that the load can be thrown from engine to motor, or back again, without any interruption of service.

The motors start entirely unaided, coming up to synchronous speed in about 50 seconds from the time the current is thrown on. They are, like the generators, separately excited, the exciters being driven from the pulleys on the end of the motor shaft.

The efficiency of the complete transmission at full load, from the power applied to the dynamo pulley to that delivered to the motor pulley, is just 80 per cent. In originally starting the mill, before the second motor was ready for operation, it was the custom to bring the motor up to speed and then gradually throw in the clutch connecting it to the shafting already running from one of the engines. When the clutch was fully in and engine and motor running together, the engine was disconnected by its clutch and the power transferred entirely to the motor. This could be done without producing the slightest disturbance in the speed, and in the same way, now that both motors are in and the engines shut down, the load can be shifted from one motor to the other, if desirable. Ordinarily, however, there is work enough for both, when driving the 1,700 looms in the new mill, operating the lighting plant and the three 80-h. p. General Electric railway generators, installed in another part of the basement. The first motor was started more than two months ago, and the complete plant, entirely installed by the Power and Mining Department of the General Electric Company, has now been in operation for several weeks, entirely displacing the steam service and performing its duties in a highly satisfactory manner.

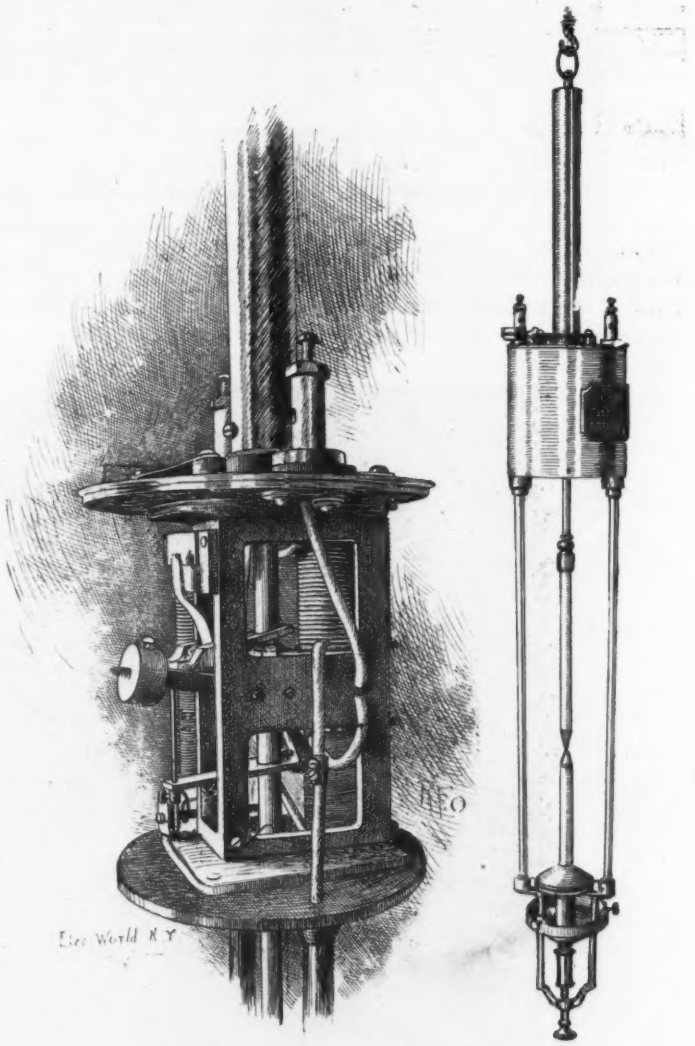
The New Bain Arc Lamp.

The new Bain arc lamp has been recently put on the market by the Great Western Electric Company, of Duluth, Mich., and the illustrations show the general appearance and the mechanism of the lamp. The latter is quite simple, there being but two hollow magnets or solenoids, the main or lifting magnet being placed above the shunt or feeding magnet. The use of but two magnets makes a lamp of lighter weight and less cost, while the action is sufficiently strong and delicate to serve every purpose, so that a satisfactory working lamp is assured with the least amount of mechanism.

The clutch consists of a simple bar of brass, perforated for the rod, one end being suspended from the lifting bar by a double link, the other end connected with the opposite end of the lifting bar by an adjusting screw, thus making the action differential and more delicate than is usual in such lamps. The lifting bar is counterbalanced by an adjustable weight, thus providing for more delicate adjustments than could be obtained by a single contrivance and yet retain the desired simplicity.

The automatic cut-out consists of a strip of brass attached to a supplementary piece, pivoted above the lifting bar and facing a contact piece, which is insulated from the other portions of the lamp by being secured to a plate of non-conducting material. Sufficient resistance is supplied, in the short circuit made by the cut-out, to insure that the cut-out will not fail to maintain the conditions for which it is provided, so long as the other mechanism of the lamp fails to operate in the proper manner, a condition never found so long as the lamp has the necessary care. The cut-out is brought into action by the pull of the shunt magnet, so that it can be relied on to act in case anything should happen to call for such service.

The solid rod of the lamp is of hard brass, which cannot be easily bent, thus providing against another defect found in some lamps. The lower end of the rod is fitted with an adjustable carbon holder that permits of the carbons always being placed in proper alignment with the least amount of trouble and with a saving of time, a feature of importance when many lamps are to be recarboned in a short time. A simple but efficient switch for cutting the lamp out of circuit is placed on the top, where it is out of the way of accidental closure, but easy of access when required. The shadeholder contains a receptacle for all carbon dust which inevitably forms from the consumption of the carbons.



THE BAIN ARC LAMP.

This holder can be easily removed from the lamp and cleaned without removing the shade from the holder. All parts of the lamp with which a person is liable to come in accidental contact are carefully insulated.

New Westinghouse Electric Railway Equipment.

In order to meet the requirements of street railway companies that may desire, for reasons of their own, motors lighter than the standard type, and especially having less weight upon the car axle, the Westinghouse Electric and Manufacturing Company has recently brought out a new type, known as Nos. 10 and 12, the former being of 40 and 50 h. p. and the latter of 20, 25 and 30 h. p. In addition the same company has developed a new type of controller, diverter, fuse block, switch and lightning arrester, thus enabling it to offer a complete new car equipment.

The new motor differs materially from the older type only in the absence of an iron supporting frame, which has been incorporated into the upper half of the field in the new motors, and thus also forms part of its magnetic circuit, while giving sufficient strength to hold the armature shaft always in perfect alignment with the car axle. On the side which is farthest from the axle of the car, the two halves of the yoke are hinged together, so that the interior parts of the motor are made easily accessible without the necessity of dismounting.

The lower field casting has three openings, one directly below the commutator and the others at opposite ends of the casting. These openings are closed by water-tight covers, which may be removed to give access for the purpose of repair or removal of dust or dirt.

The field coils are wound and insulated in the same manner as in the older type, although the capacity of the winding has been somewhat increased and the insulation is made, if possible, even more thorough.

The two brush holders, 90 degrees apart on the top of the commutator, are held in position by a frame which is so designed as to constitute a part of the end of the upper field, and, together with a lid, completely encloses the commutator end of the motor, and entirely protects the inner parts. The lid is hinged and normally kept closed by a stiff spring.

The new platform controller has two removable handles, one for controlling the speed and the other the direction of travel of the car. The handles are provided with locking devices, which prevent their removal, except when in the position for no current. The electrical combinations of the motors made by the new controller are improved over those of the earlier type, in that the motors divide the work equally, and the car starts more easily and attains its maximum speed more smoothly. The construction and operation of the new controller are similar to that of the old type, and it is designed with special reference to making inspection as simple and as easy as possible. The controller drum is so supported that it can be swung clear of the contacts, the supports for the two bearings of the drum shaft being hinged at one side of the controller back, thus giving ready access to the drum and contacts.

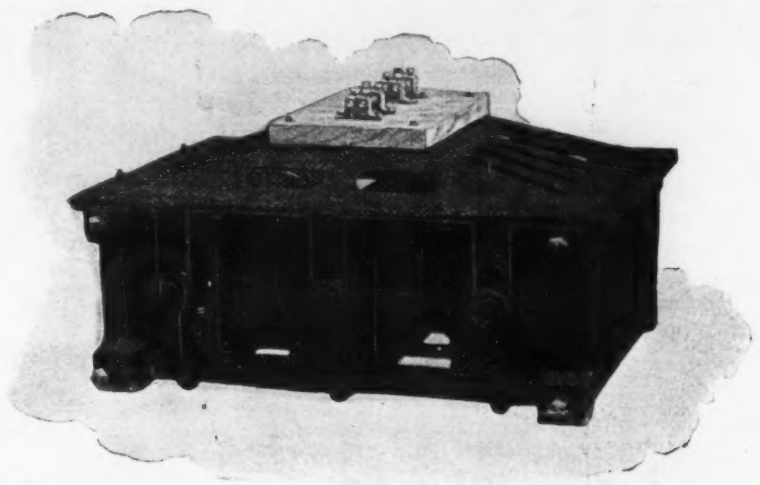
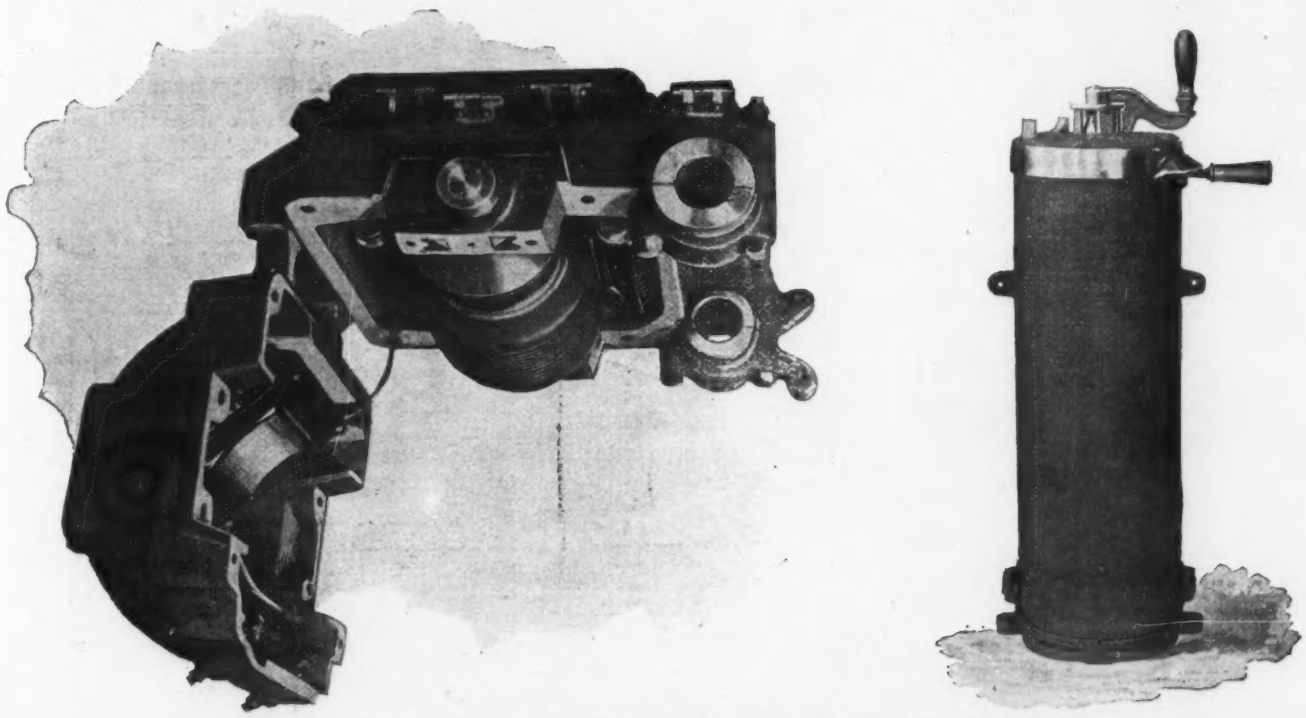


FIG. 3.—NEW DIVERTER.

The controller is made both fire and waterproof. The cover of sheet iron, lined with asbestos cloth, is easily and quickly removed. The cylinder or drum is built up of thick porcelain and vulcabeston rings, the latter extending sufficiently beyond the porcelain to render arcing from one contact to another impossible. By raising the points of arcing above the surface of the insulator, any tendency to disintegrate the porcelain is avoided. The contact strips are made



FIGS. 1 AND 2. NEW STREET RAILWAY MOTOR AND CONTROLLER.

with replaceable tips. At the left of the drum are placed the contact blocks, which resemble short, thick fingers split diagonally into two sections, to secure perfect contact and even wear. Either motor can be cut out of circuit by the removal of a plug, thereby rendering unnecessary the use of the usual cut-out box within the car. The reversing handle projects from the side of the stand, a single throw of which reverses the current in both motors.

The new diverter differs somewhat from the former styles, and has been designed for use with the above controller. The resistances are made up of strips of sheet iron placed between strips of mica, the whole being then wound compactly into coils. The coils are enclosed in iron cells, which are afterward threaded on an insulated support and thus built up into short cylinders. Three of these cylinders, thoroughly insulated, are supported in a light, cast-iron frame box. The terminal block consists of a marble slab, carrying four binding posts, to which are connected the wires to the controller. Thus the diverter is made completely fireproof, and at the same time there is provided the very best ventilation. One of these diverters is used on each car, its function being to reduce the current while the motors are being started, thereby preventing the sudden jerking of the car and unnecessary strains on the motors.

Three other pieces of apparatus comprising the equipment are a canopy switch, fuse block and lightning arrester, all of which display in their design the most careful consideration of the practical points involved.

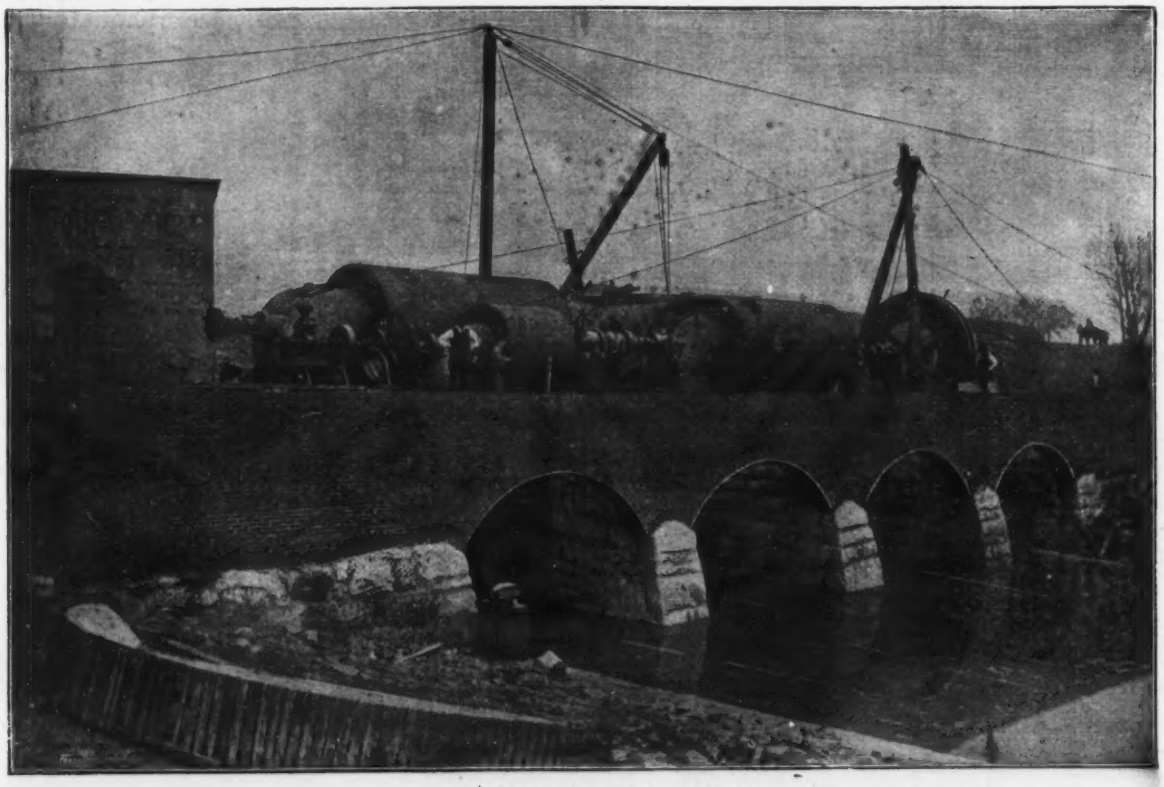
The method of suspension relieves the axle of practically all the direct weight of the motor, and avoids what has been termed "hammering" of the rail joints. By reason of the increased strength of the upper field yoke, it is possible to suspend the motor directly in the line of its centre of gravity, by means of suspension bars, which run parallel to the sides of the truck, and have their ends supported upon spiral springs. The motor is thus freed from jars, and yet accurately maintains the meshing of the gears while yielding to the motion of the truck. This important feature of the new motor will be easily understood by reference to Fig. 1.

By reason of improvements, which have been introduced, and of a more efficient utilization of the iron in the fields and armature and of the copper in the windings, it has been possible to effect a material reduction in the weight of the new motor. This has been done only so far as it was believed consistent with a margin of mechanical strength adequate to meet the severe conditions of electric traction.

Reference to Fig. 1 shows the ample provision which is made for the rapid yet thorough inspection of the fields and armature. The hinged lid, already referred to, permits ready handling of the brushes and inspection of the commutator. The openings in the lower field afford access to the lower part of the motor. When it is desired to gain access to the whole interior of the motor, the car is run over a pit and the lower half of the field opened down, either with or without the armature, as may be desired. The armature bushings are carried in pillow blocks, which, when the motor is closed, are secured to both the upper and lower field. By removing the bolts holding the pillow blocks to the upper half of the field, the lower half may be opened down with the armature, which can then be rolled out upon a board, thus avoiding the necessity of lowering the armature into the pit and again raising it. By removing the bolts between the pillow blocks and the lower half of the field, the armature is kept in the upper half of the field, permitting removal of the field coils, etc., in the lower half. The lower half of the field is readily opened down by the use of a rope passed around the axle, which is thus made to take the part of a pulley block. By the above construction and arrangement of parts, all repairs can be easily made from the pit, and consequently the grease and dirt accompanying repair work is not introduced within the car, a feature which will be at once appreciated.

Power Plant for Cotton Mills.

The Columbia Cotton Mills Company, of Columbia, S. C., is to use electricity for power, and a generating plant of 1,400 h. p. has been installed. The power plant consists of



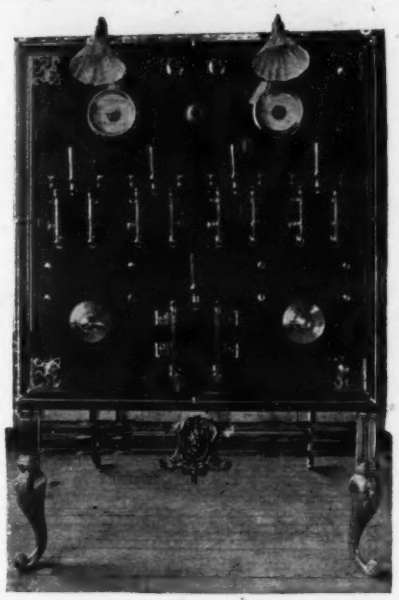
DIRECT-CONNECTED VICTOR TURBINES AND DYNAMOS, AT COLUMBIA, S. C.

two pairs of 48-inch cylinder gate Victor turbines on a horizontal shaft, with a single 24-inch horizontal Victor turbine for driving the fire pump. The two pairs of 48-inch turbines are connected together and at each end are direct connected to a generator of 700-h. p. capacity, made by the Gen-

eral Electric Company. This is the second instance in America where an entire cotton mill will be driven by electricity. The entire power plant was designed and furnished by the Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio, in connection with the plans for the mill, which were furnished by Lockwood, Greene & Co., of Boston, Mass. The cut shows the Victor wheels in position with direct connection to dynamos.

Incandescent Switchboards.

The Electric Engineering and Supply Company, of Syracuse, N. Y., has placed on the market something new in the



INCANDESCENT SWITCHBOARD.

line of switchboard fittings, a small illustration of which is herewith given. All the unsightly apparatus, so far as practical, is mounted on the back of the slab, thus not only enhancing the appearance of the board, but in many instances economizing space. In mounting rheostats, for example, an adaptation of a graduated dial and index finger is used, which is all that appears on the face of the slab, and has a general appearance of a dial on a safe lock, the degrees on the dial corresponding with the steps of the rheostat. Voltmeters and ammeters are similarly mounted, bringing the dial flush with the slab, and set off with polished metal rings. To conform with the rules and regulations of the State Board of Fire Underwriters, the company is prepared to furnish numerous designs for mounting these boards upon metal standards and frames, neatly wrought out of brass or iron. The highly finished E. E. & S. station switches form an attractive part of the outfit.

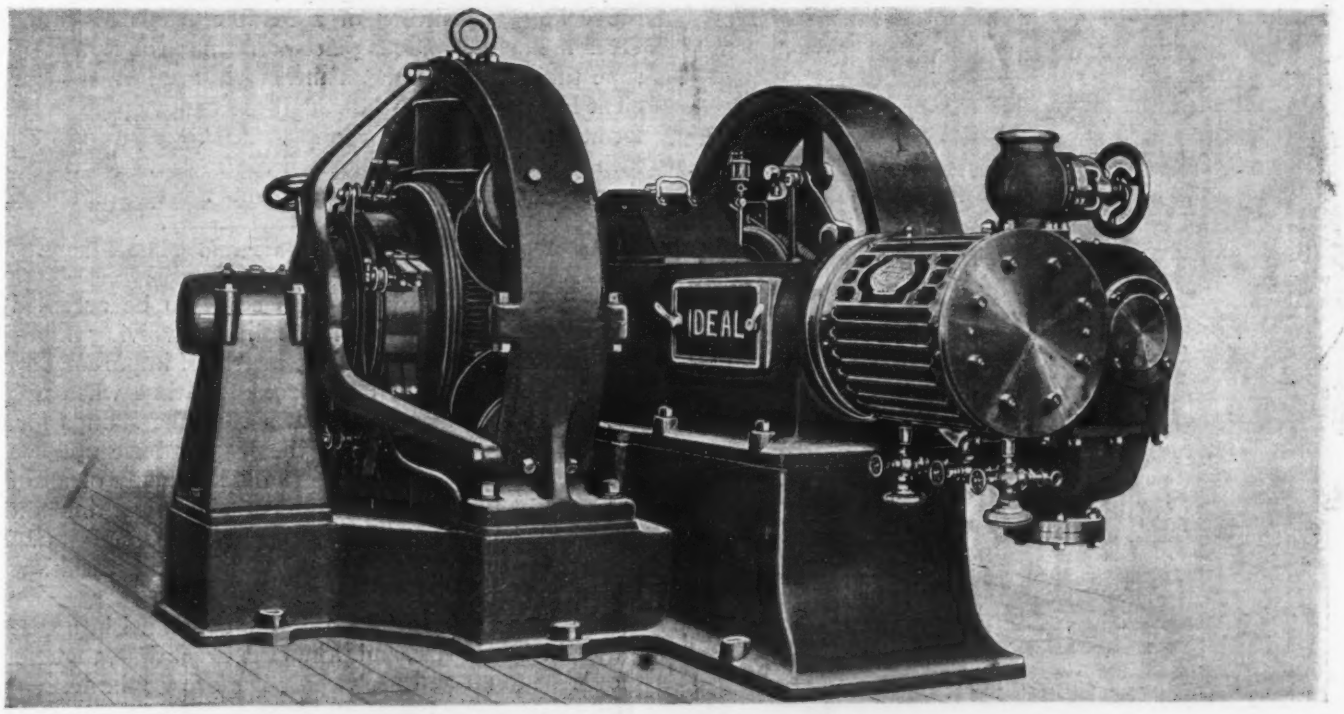
Direct-Connected Engines and Dynamos.

That the day of belted dynamos is drawing to a close is evident from the increased attention given by engine builders to the design of engines for direct connection, as well as from the tendency toward electrical generators of low speed, and we illustrate herewith one of the most recent of these combinations, which our readers will find of interest.

The engine is the "Harrisburg Ideal," self-oiling pattern, manufactured by the Harrisburg Foundry and Machine Works, Harrisburg, Pa., and has a cylinder 12 inches in diameter and 12 inches stroke. The dynamo is one of the General Electric Company's multipolar type, with a capacity of 50 kw., giving 450 amperes at 110 volts, the speed being 275 revolutions per minute.

The self-oiling, outboard bearing feature in the engine shown is designed on a generous model, and has the latest arrangement of a movable sleeve with ring oilers, being, except for increased weight and size, of almost the same construction as the standard Edison bipolar dynamo bearings, which have been proved by years of service to be so excellent.

A test of the combination shown was made recently in New York City, in the presence of several gentlemen well informed on steam and electrical matters. The engine was started in the usual manner under steam, and when running at the desired speed, of 275 revolutions per minute, the brushes were adjusted and the engine and dynamo prepared for taking on the load. The switchboard was also arranged so that the entire current generated would pass through two switches side by side, and a 5-cent nickel balanced on edge on the outer end of the cylinder head, the engine running



DIRECT-CONNECTED ENGINE AND DYNAMO.

at friction load. The two switches were then taken in hand and thrown in instantly, whereupon the ammeter showed 340 amperes; the switches were then thrown out at the end of seven seconds, then in and out again, thus throwing upon the engine practically the full load of the dynamo twice within fourteen seconds, during which the 5-cent piece remained balanced on the cylinder head, showing the combination to be operating absolutely without any vibration whatever. There are now, we are informed, between 30 and 40 combinations of this type in successful operation.

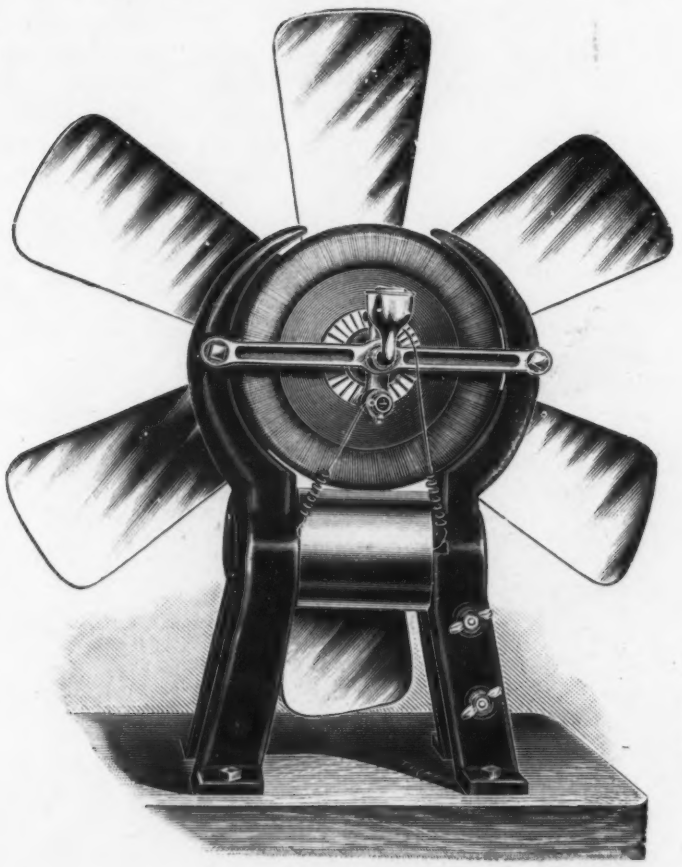
Metropolitan Fan Motors.

The fan motor shown herewith is manufactured by the New Haven Insulated Wire Company and presents a new feature in electric ventilating apparatus, inasmuch as it carries a 24-inch wheel. Run at quarter or half speed, the fan creates a very pleasant breeze, not so sharp as that created by a buzzer, but much more diffused, and makes no noise, taking a trifle over a half ampere on a 110-volt circuit.

At full speed the fan makes 720 revolutions per minute and takes about one and a half amperes, and exhausts about 7,500 cubic feet of air per minute, doing fully as much work with a less expenditure of power as any 24-inch exhaust wheel making the same number of revolutions driven by belt either from a line of shafting or direct from a motor.

The fan is of very strong construction, has tempered copper commutator, self-feeding carbon brushes and large oil cups; all running parts are protected so that they cannot become clogged with dust or dirt; it requires the minimum amount of attention.

It is nicely finished in black japan and nickel, and is a

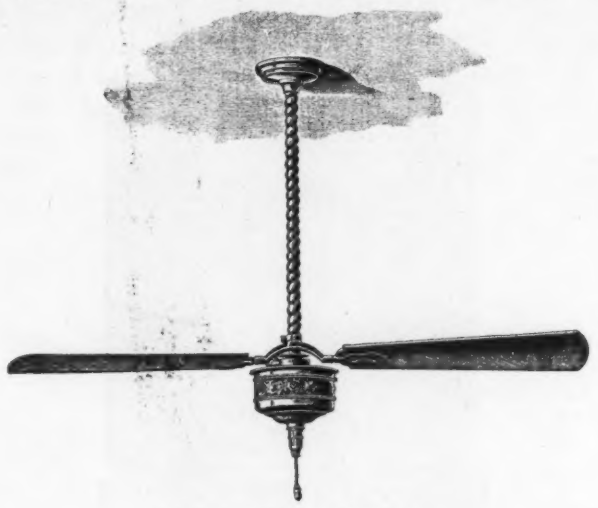


NEW FAN MOTOR.

very neat looking machine. A speed regulator is furnished with every fan, whereby four speeds may be obtained. They are ordinarily wound for 110 volts direct current, but are also made for 220 and 500 volt circuits and for arc light currents. Doubleday, Mitchell & Co., 136 Liberty street, are agents for New York City and vicinity.

Electric Ceiling Fan.

A new type of electric fan motor, now being placed on the market by the Interior Conduit and Insulation Company, 44 Broad street, New York, under the name of the "Lundell 1894 model," consists of a 4-pole field carrying a stationary vertical steel spindle attached firmly to an under spider. The armature is built up of the usual laminations of soft iron on a gray iron centre and all carried on a composition sleeve, which sleeve slips over the stationary spindle and rests upon a shoulder at the bottom. The armature



ELECTRIC CEILING FAN.

sleeve also carries the holder for the fan blades. The stationary spindle on which the armature sleeve revolves is channeled out for the free passage of oil to all wearing parts; and as a part of the bottom spider, a large oil cup or recess is formed which when properly filled with three tablespoonfuls of thin oil will insure perfect lubrication for several years. The oil is introduced to the motor at the upper end of the composition sleeve which carries the armature. A very simple device is employed for attaching the motor to the ceiling, consisting of a flexible insulated connection. Over the hanger pipe is placed an ornamental piece of brass rope tubing. Wires from the motor are furnished of sufficient length to pass up through the hanger pipe to the outlet at the top over the canopy. A single pull switch is attached to the bottom spider of the motor. As the illustration shows, the combination presents a very neat appearance.

Automatic Electrical Date and Time Stamp.

A date and time stamp has come to be accepted as a necessity in the conduct of a business involving a large correspondence, and where it is a matter of importance to have a record of the exact or approximate time when a certain matter received attention. As a rule, the stamps for these purposes heretofore put on the market have not been entirely satisfactory, and it was to obviate many or all of their defects that the Hoggson automatic electrical time and date stamp, which we illustrate, was devised, and now being placed on the market by the Automatic Electrical Specialty Company, 136 Liberty street, New York.

The mechanism of the stamp is contained in a case 2 by 3 by 3 inches in size, and prints the exact time, together with the day, month and year, changing every minute, requiring setting only once a month. The machine consists of a system of endless rubber printing bands, which are so arranged as to move automatically, bringing the proper characters into position to print the exact time and date. Rubber printing bands are not new, but in this instance a number of them are grouped upon one or more shafts, each turning independently of the other, so that the utmost exactness is

obtained in getting an impression. A set of these bands are grouped about in the case in such a manner that a small current, such as generated by a Lelanche cell, passes through an electromagnet in the case and actuates an armature, which, in turn, by means of a lever, moves the first or minute band,

AUTOMATIC DATE AND TIME STAMP.

one notch, which changes the minutes. At the end of the ninth minute the 10-minute band receives an impulse, which changes that band, and a similar movement at the end of 60 minutes changes the hours, and, at the proper time, the A. M., M., or P. M. bands are also changed. At midnight the day band is changed, and only once a month does the stamp need setting.

The stamp can be connected with any clock and any number of stamps can be connected with one clock, which serves admirably in factories or offices as a combined employees' time stamp, watchman's clock and general check system. In railroad or telegraph systems all the stamps can be connected to one master clock, which will operate all at the same instant.

The stamps can also be so arranged as to print the time in connection with fire alarm, police and messenger registers. Any die up to 2 by 2 1-2 inches may be used in connection with the stamp and can be instantly removed if desired. As the entire impression is made from rubber the machine requires no pounding to operate. The ink is fed by an automatic device, which renews at every impression.

The Lawrence Conduit for Street Railways.

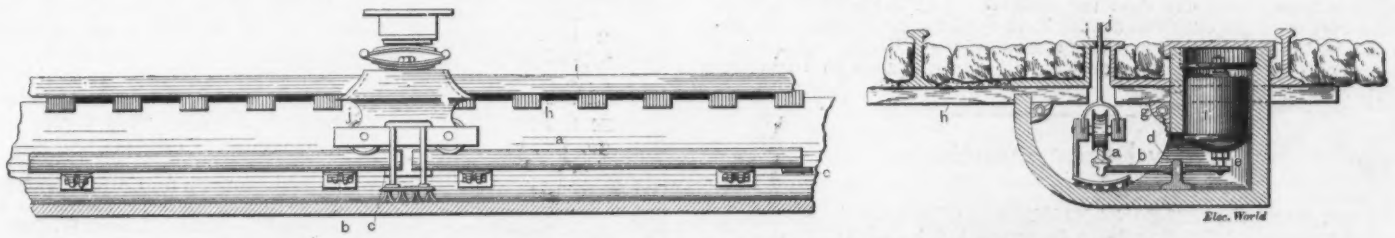
A new departure in conduits for electric railways has been brought out by the Lawrence Electric Company, of 13 Astor place, this city. Its operation is entirely mechanical, and for reliability, simplicity and low cost of construction it is claimed to be a strong competitor of the overhead trolley.

A road has been built in the yards of the Harlan & Hollingsworth company, at Wilmington, Del., in which the system has been put to the most severe tests since March 14, with most gratifying results. Nearly the whole track during the recent severe storm was flooded with salt water to a depth of three feet, the car having been left at the top of a slight grade, which saved the motors, as the water only reached to the lower edge of them. The electrician procured a boat and rowed out to the car and, getting aboard, turned the switch; the car answered nicely, and was run back and forth several times as far as the water would permit without immersing the motors, everything working perfectly.

The car is a T.-H. open summer car, weighing nine tons. It has been run on this track loaded at a speed of twelve miles per hour, the length of the track precluding any higher rate, but there is no reason why it will not be successful at any speed.

The conduit as now constructed consists of an inverted T-shaped girder rail, *a*, resting on two balanced arms, *b*; these rails are 32 feet long and joined together at their ends by means of pieces of vulcanized hard fibre boards, *c* screwed to the under side, making practically a continuous flexible rail, with an insulating air space between each section. The balanced arms, *b*, are fulcrumed on a spindle at *d* and are connected to a rod, *e*, that enters the box *f* through the flexible bottom. A branch of the feed wire *g* enters the top of the box and makes electrical contact with the rod *e* when the latter is raised by the weight of the trolley at the other end of the arm *b*. The current then goes through *b*, and *a* to the trolley wheels. The collector *j* is a compound affair; that is, has two wheels, one placed about six inches forward of the other and electrically connected. This prevents any break in the circuit in going from one section to another and prevents arcing in the boxes.

The conduit proper is made of vitrified clay moulded in the form of an elliptic cylinder and cut lengthwise, forming two lengths from each casting. These are placed end to end. The ties *h* are laid directly on, and project over to form a support for the cover *i*, which consists of two iron pieces of L-shaped section, one on each side, with a space between to allow the trolley to pass. Then the track is paved with stone and concrete. The trolley runs equally well backwards or forwards, and cannot possibly leave the girder rail; consequently there is no danger of losing the current at critical periods. In a double track the box is placed between the tracks, the one box acting for both tracks, but is so constructed as to make electrical connection to only one track, unless there is a car upon each track, when it makes electrical connection to both.



LONGITUDINAL AND VERTICAL SECTIONS OF STREET RAILWAY CONDUIT.

At the office of the company, at 13 Astor place, there is a small working model of the system. A track is arranged around the room, on which a small car runs, illustrating the system very clearly. An incandescent lamp held at any section, except the one that the car is on, shows no light, but lights up instantly as soon as placed at that section.

Messrs. Hicks Bros., of 59 Wall street, of which firm Mr. George E. Hicks is president, are the financial agents of the company.

Financial Intelligence.

The Electrical Stock Market.

NEW YORK, April 30, 1894.

GENERAL ELECTRIC.—The transactions in this chief electrical security have been of little consequence during the week, and the stock has dropped a fraction over a point. The depreciation is due primarily to the prevailing dullness in the exchange in all electrical and industrial stocks, and to the lack of any good news which would increase its position. For General Electric, of all the stocks, seems to need constant rumors of big contracts and great profits ahead to maintain its standing. As a result of no inside "booms" the bears have had their own way with the stock, and succeeded in making the closing bid for the week at 38⅝. There is no definite information as yet whether the company will reduce its capital stock or not, but it is thought quitt probable that it will do so. The officials of the company are still at work cutting down all superfluous expenses and attending zealously to the manufacturing interests, so that the stock may in time regain its former prestige.

WESTINGHOUSE ELECTRIC.—The good talk on this stock continues, and though trade is not large, there is unflagging confidence in the stock's future. The company's business for the past 12 months has been excellent, and it is thought if it continue at the same rate for a year, the company will be out of debt and in a position to again declare dividends. Current reports have it that at present the company owes less than $1,000,000 and has over $2,500,000 due to it. Every effort is being made by the management to put the company's affairs on a profitable basis. The annual report of the directors will be out about May 10, and the officials say it will show the company in a very favorable light.

THE AMERICAN BELL TELEPHONE COMPANY is now doing a remarkably big telephone business. The company's instrument output for the month ending April 20 makes the best showing in many months, and the number of new instruments is nearly five times as great as that of the previous month. The stock has advanced to 191 during the week, and with the prospect of good business ahead, quotations will probably appreciate considerably in the near future.

THE COMMERCIAL CABLE.—A majority of the stockholders have certified at Albany that of the $10,000,000 authorized capital stock $9,618,100 has been issued and paid in, in cash and property. The existing debts are declared not exceeding $700,000, consisting of debenture bonds and sundry obligations, while the assets are certified to amount to $12,000,000, including all of the machinery and real estate of the company. The stock does not vary much, and is now bid at 130.

WESTERN UNION TELEGRAPH stock is now receiving much adverse criticism, and is not making any advances either in quotations or in market standing. It is asserted by a number of financial journals that though Western Union was a leader in stock transactions during the early part of the winter, the stock is now rather inactive, and while most of the stocks have gone up in quotations, Western Union has depreciated. There has also been a report recently that the company had reduced wages, but this rumor lacks confirmation. It is said that owing to the long prevalent light business, the company is gradually reducing its force of operators, and is cutting all expenditures to the lowest figure.

New Incorporations.

THE TAYLOR-BELDING ELECTRIC COMPANY, Chicago, Ill., capital stock $10,000, has been incorporated by C. H. Taylor and others.

THE INTERNATIONAL ELECTRICAL SUPPLY AND MANUFACTURING COMPANY, Detroit, Mich., has been incorporated. The capital stock is $500,000.

THE SHELBYVILLE WATER AND ELECTRIC LIGHT COMPANY, Shelbyville, Ky., capital stock $40,000, has been formed, with Louis Channing as president.

THE UTAH-NEVADA COMPANY, Council Bluffs, Iowa, capital stock $5,000, has been formed to contract for railway work, telephones and telegraph lines, etc.

THE ST. JOSEPH AND LAKE SHORE ELECTRIC RAILWAY COMPANY, St. Joseph, Mich., capital stock $75,000, has been formed to construct an electric railway.

THE MARTINSVILLE ELECTRIC COMPANY, Martinsville, Ind., capital stock $10,000, has been formed. J. K. Scott, J. R. Starkey and H. A. Smock are interested.

THE NATIONAL HEAT AND POWER CONSTRUCTION COMPANY, Philadelphia, Pa., has been incorporated by L. G. McConley and others. The capital stock is $150,000.

THE ALLEGHENY AND BUTLER RAILWAY COMPANY, Pittsburgh, Pa., capital stock $300,000, has been formed to construct and operate an electric railway. W. L. Mustin, C. K. Hill and F. Gwinner, Jr., are interested.

THE ETNA AND GLENSHAW STREET RAILWAY COMPANY, Pittsburgh, Pa., capital stock $50,000, has been formed to build and operate an electric railway. W. I. Mustin, C. K. Hill and F. Gwinner, Jr., are the organizers.

GREGORY REED COMPANY, Chicago, Ill., capital stock $60,000, has been formed to promote, engineer and construct electric light plants, waterworks and other public works. J. H. Gregory, W. S. Reed and M. L. Coffeen are interested.

THE BAKER CITY ELECTRIC LIGHT COMPANY, Baker City, Ore., capital stock $60,000, has been formed to construct and operate an electric light plant. J. A. West, C. W. Nibley, Jr., and C. W. Nibley, all of Baker City, are interested.

THE ECONOMIC GAS COMPANY, Buffalo, N. Y., maximum capital stock $100,000, has been formed to generate, sell and distribute electricity and gas to be used for heat, light, power, etc. J. Busch, G. F. Layer and W. C. Busch are interested.

THE KNOXVILLE LIGHT, HEAT AND POWER COMPANY, Knoxville, Pa., capital stock $2,000, has been incorporated to supply light, heat and power by electricity. W. J. Hunter, Wm. Hunter and James F. Grimes, all of that town, are the organizers.

THE SAVOY, MACHINE COMPANY, New York, capital stock $2,500, has been formed to manufacture electrical and other machines. The promoters are J. Bradley, 5 Dey street; F. M. Archer, 5 Dey street, and W. M. Earl, 32 West 128th street, New York.

THE VICTOR LIGHT, WATER AND MOTOR COMPANY, Victor, Colo., capital stock $100,000, has been incorporated to furnish electric light. J. E. Downey, J. R. Perry, J. Downey, J. B. Downey and C. M. Lawson, Pueblo, Colo, are those interested.

THE CHICAGO HEIGHTS WATER, LIGHT AND POWER COMPANY, Chicago, Ill., capital stock $100,000, has been formed to construct electric, gas and water works, and fixtures for same. H. L. Wallace, H. Abbott and M. H. Kilgallen are interested.

THE ST. LOUIS ELECTRIC BRAKE COMPANY, East St. Louis, Ill., capital stock $2,000,000, has been formed to acquire patent rights and to equip electric, steam and street railway cars. J. L. Black, Samuel Resh and W. V. Wolcott are the incorporators.

THE MILWAUKEE STEAM HEATING AND ELECTRIC CONSTRUCTION COMPANY, Milwaukee, Wis., capital stock $25,000, has been formed to do electrical construction, aso general steam and hot water heating. The promoters are H. Jane, G. Kuntz and G. Crooke.

THE WORLD MANUFACTURING COMPANY, Columbus, Ohio, capital stock $100,000, has been formed to make and deal in all kinds of electric motors, telephones, engines, boilers, machinery, etc. The organizers are W. P. Harrison, H. F. Gray, H. A. Williams, L. G. Addison and Lincoln Fritter.

THE SAN DIEGO, PACIFIC BEACH AND LA JOLLA RAILWAY COMPANY, San Diego, Cal., has been incorporated with a capital stock of $25,000. Herbert Dabney is among those interested. It will build and operate a street railway from Pacific Beach to La Jolla Park, a distance of four miles.

THE BURTON ELECTRIC HEATING AND FORGING COMPANY, Berwick, Me., capital stock $1,000,000, has been formed to manufacture and deal in all kinds of electrical machinery and apparatus. F. J. Hutchinson, Hyde Park; A. Wiswall, Woburn, and G. D. Burton, Boston, Mass., are the interested parties.

THE JOBBINS MANUFACTURING COMPANY, First National Bank Building, Jersey City, N. J., capital stock $100,000, has been formed to manufacture carbon for electrodes, glass cylinders, globes, shades, etc. The incorporators are G. H. Low, 660 East 23d street, Paterson, N. J.; W. N. Southworth, 160 West 129th street, and C. B. Harris, 250 West 36th street, New York.

THE ELECTRIC SMELTING AND ALUMINIUM COMPANY, Chicago, Ill., capital stock $100,000, has been incorporated for the operation of the processes of electric smelting and electrolysis for the production of aluminium and other metals and alloys, the purchase and ownership of patents relating to such processes, and to manufacture and sell goods from such products. Alfred H. Cowles, Loren Prentiss and Chas. M. Vorse are the interested parties.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, April 30, 1894.

MR. MORTIMER NORDEN, 136 Liberty street, New York, will shortly place upon the market a new electric fan motor.

MR. WM. H. McKINLOCK, president of the Metropolitan Electric Company, Chicago, was in New York during the past week.

THE KNAPP ELECTRIC AND NOVELTY COMPANY, 34 Warren street, New York, is securing quite a run on its No. 15 fan motor outfit.

MR. FRANK A. MAGEE, traveling sales agent for The E. S. Greeley & Co., 5 and 7 Dey street, New York, was in town for a few days last week.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Brooklyn, N. Y., has placed an order with Wm. Tod & Co., of Youngstown, Ohio, for two 1,200-h. p. engines.

"MICANITE," manufactured by the Mica Insulator Company,

218 Water street, New York, continues to grow in favor as an insulating material not only in this country, but also abroad.

MR. J. E. HAM, general agent for Kerite, manufactured by W. R. Brixey, 203 Broadway, New York, reports having closed several large orders for this well known wire during the past week.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 32 Cortlandt street, New York, is pushing its works to their utmost capacity, filling orders for telephones. Its Mesco dry battery continues in public favor.

MR. J. C. MOULTON, formerly connected with the A, B, C Company, now represents Messrs. J. Jones & Son, 67 Cortlandt street, New York, manufacturing electricians and dealers in electrical supplies. Mr. Moulton's territory embraces New York City and vicinity.

THE KNAPP ELECTRIC AND NOVELTY COMPANY has removed its office and salesroom to 47 Warren street, where it is prepared to do a large business. The sales of this company for April were larger than last year.

MR. O. P. LOOMIS, of Bound Brook, N. J., referring to a note in a recent issue of The Electrical World, that an old subscriber had on exhibition a copy of the March 8, 1884, issue of this journal, writes to say that he has been a subscriber since May, 1883, and has in his possession each issue since Jan. 1, 1884.

MESSRS. J. JONES & SON, of which firm Mr. Ernest A. Lowe is manager, now occupy the entire first floor of 67 Cortlandt street, New York. Messrs. Jones & Son recently purchased from the receiver the stock of the A, B, C Company, which, together with their own, places them among the first of the large electrical supply houses.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., April 30, 1894.

THE STATE SENATE has passed to be engrossed a bill providing for the heating of street cars.

THE IONA MANUFACTURING COMPANY, of Boston, reports exceedingly good business for its electrical specialties. It is running full time and full force.

MR. H. C. HAWKS, of the Hawks Electric Company, of Boston, has been greatly bereaved recently through the death of his estimable wife, and regarding which we beg to assure him of our sincere sympathy and that of all of his many friends and acquaintances.

THE MATHER ELECTRIC COMPANY reports the sale of two 120-kw., 500-volt railway generators to the Fox Electric Railway Company, of Green Bay, Wis. This sale was made through Mr. J. Holt Gates, of 1140 Monadnock Building, Chicago, Ill., Western contractor for the Mather company.

IT IS REPORTED that the Schuyler Electric Company, of Middletown, Conn., will close its works May 1, awaiting the result of a reorganization. The company is said to be in good financial condition, and the plan is to reorganize it independently of the General Electric Company, with which it has so long been closely associated.

THE CITY OF LOWELL has been sued by the Municipal Signal Company for alleged infringement of patent, by using the Gamewell signal service. The city is protected by an agreement made with the Gamewell company. The recent decision in favor of the Municipal company as against the other company for infringement is the base of complaint.

G. M. ANGIER & CO., 116 Bedford street, Boston, have been appointed exclusive agents in New England for the Kester arc lamp, the Climax ironclad rheostats and stage dimmers and the Sechrist automatic switch, all of which are first-class electrical specialties in their particular lines, and for the introduction of which a more energetic or reliable firm could not have been found in New England.

THE BOSTON INCANDESCENT LAMP COMPANY, through an unfortunate error in this column last week, was reported as having been served with an injunction, as the result of the lamp suit argued on April 14. No opinion has yet been rendered, and the remarks from the bench, as reported in our editorial columns last week, are regarded as very favorable toward the contention of this company.

MR. FREDERICK W. GORE has invented a street railway system, which he calls the "tandem, compound, electric system." The locomotive and cars rest on flat platforms, which run close to the floor or pavement, and are carried on trucks which are below the surface. The slot in the floor or pavement is only three-quarters of an inch wide, and only light surface rails are required, as the weight is nearly all supported by the underground construction.

THE ELECTRICAL FORGING COMPANY, of Boston, has decided to locate its factory at Woburn, Mass., where it has purchased two acres of land directly adjacent to the Boston and Lowell tracks. Work upon the building will be commenced May 1, and the contract calls for its completion by June 1. The factory will be run by water power, and will possess all improved facilities. President G. D. Burton is to be congratulated upon the progress he is making for his company, which, without the saying almost, is entirely due to his untiring energies. Mr. Burton has also been successful in organizing a company for the six New England states, to be known as the Burton Electric Heating and Forging Company, organized under the laws of Maine, and with a capital stock of $1,000,000, of which he is president and F. J. Hutchinson, of Hyde Park, treasurer.

CAPT. WM. BROPHY, the well known electrical and insurance expert, is prominently mentioned in connection with the underground wire question in Boston, and should it finally become a law, it is reliably stated that he will undoubtedly receive the appointment of chief official. It is almost needless to say that his appointment would meet with universal favor among the electrical and insurance fraternities, and the public may rest assured that the duties of the position will be discharged upon honest business principles and that politics will cut no figure whatever. Captain Brophy is not seeking the position, but has been urged so strongly by his friends for permission to present his name, that he has finally yielded and given them permission to do so.

Western Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
936 Monadnock Building CHICAGO, April 28, 1894.

THE FIRM OF BOWDEN & SEARS, Cambridge City, Ind., has succeeded W. Q. Sayers in the electric lighting business.

GEORGE CUTTER reports large orders for his new swivel pole pulley, the improved form of this being evidently "just the thing."

THE WALLACE ELECTRIC COMPANY has moved to its new quarters, 307 Dearborn street. It reports a large and increasing business in the sale of the Wirt improved dynamo brush and the W. W. lightning arrester.

THE MOSHER ELECTRIC COMPANY takes pleasure in stating that recent sales of its new alternating lamp have been unusually heavy. Its other arc lamps are also meeting with favor wherever installed.

JAMES A. ROSE & CO., Title and Trust Building, Chicago, Ill., have purchased the entire stock of incandescent lamps of the Ansonia Electric Company, and are now offering them for sale. Most of them are 16 c. p. and of various makes, voltages and bases.

THE STANDARD ELECTRIC COMPANY is very much gratified at the reception which has been accorded its new alternating apparatus. Already it has sold several generators, and the number of inquiries indicate that its sale will be unusually large during the present season. The active appearance of its factory would also indicate a very large sale for its other types of apparatus.

THE CENTRAL ELECTRIC COMPANY.—President McKinlock is now comfortably settled in his handsome office on Adams street. The finishing touches are being put on to the store, which certainly presents a handsome appearance. Three floors are required to accommodate the stock of this company, covering in all about 37,000 square feet. Mr. McKinlock reports business as unusually good.

BARTHOLOMEW, STOW & CO., who have long been agents for the Nutting arc lamp, have now an arc lamp of their own, which possesses many features of value. Their old store at 57 Michigan avenue, having proved inadequate, they have arranged to move to new quarters at 19 North Clinton street, where they will have factory, storeroom and offices combined. This is another Western firm that reports business as unusually good.

THE ELECTRIC APPLIANCE COMPANY has been busy during the past few weeks taking possession of a largely increased floor space, and extending its facilities for receiving and shipping goods, particular attention being given to arrangements for the better handling of material in carload lots. These arrangements have been carried to a point where a carload of material can be received and put into stock or loaded for delivery within a very few hours, by means of special loading facilities, without in any way interfering with the receipt or delivery of regular orders.

News of the Week.

Telegraph and Telephone.

SUFFOLK, VA.—The Nansemond Telephone Company will purchase an equipment.

AUGUSTA, GA.—Daniel J. Murphy is in the market for telephone improvements.

SUFFOLK, VA.—L. P. Harper is interested in the organization of a telephone company.

CORDELE, GA.—Moore, Kirkland & Co., lumber dealers, are in the market for telephone equipment.

DELTA, PA.—Meetings of residents are being held in the matter of establishing a telephone system for Delta and vicinity.

CUMBERLAND, MD.—The Citizens' Telephone Company has been organized with L. D. Rohrer president. Capital stock is $40,000.

ANN ARBOR, MICH.—The Michigan Automatic Electric Tele-

phone Company will establish a plant, to include Ann Arbor and Ypsilanti.

SONMAN, CAMBRIA COUNTY, PA.—The Pennsylvania Telephone Company has been organized. Dr. Geo. R. Glass is president, J. J. McDonnell is treasurer and F. H. Young is secretary and general manager.

CLARKSDALE, MISS.—Proposals are solicited for building a telephone line from Clarksdale to Friar's Point; 13 miles of double wire will be required, with 35 poles to the mile. Proposals will be received for all or parts of the work. T. G. Dabney is chief engineer.

NIAGARA FALLS, ONT.—James Bampfield and John J. Bampfield, of Niagara Falls, Ont., and J. C. Dilcher, of Buffalo, N. Y., have formed the Colonial Telegraph and Telephone Company, capital stock $25,000, with headquarters at Niagara Falls, Ont.

LANCASTER, PA.—Owing to the fact that a local telephone company is being organized, the ordinance granting the use of the streets to the Pennsylvania Telephone Company has been tabled. Councilman Baumgardner is behind the Pennsylvania Telephone Company.

EAST AURORA, N. Y.—The Buffalo Valley Telephone Company has elected H. W. Richardson, of East Aurora, as president; N. J. D. Wooster, of Wales Center, as secretary, and Harry S. Gail, of Wales Center, as treasurer, and will at once begin work on its proposed telephone line to connect East Aurora with the villages between there and Java village.

Electric Light and Power.

VALPARAISO, IND., contemplates erecting an electric light plant.

WAPAKONETA, OHIO, is to put in a plant for electric lighting purposes.

PORTLAND, ME.—The Consolidated Electric Light Company is to increase its power plant.

CUBA, N. Y.—It is now almost certain that Cuba will put in a municipal electric lighting system.

HELENA, ARK.—The Helena Gas Company has received authority to erect an electric plant.

KERVANNA, IND., is to put in an electric light plant. Address the city clerk for particulars.

DELANO, MINN.—The town has voted to issue $10,000 in bonds for waterworks and electric light plant.

CORDELE, GA.—C. G. Barfoot, of Albany, Ga., has purchased the Edison lighting plant and will operate it.

LANCASTER, KY.—The Lancaster Ice, Light and Water Company is to construct an electric light plant.

TRAPPE, MD.—The mayor will answer inquiries regarding the electric light plant to be established in Trappe.

KINGSTON, N. C.—The mayor would like circulars and particulars as to cost of establishing an electric light plant.

ALBION, NEB., is considering the project of putting in an electric light plant. E. J. Mack, city clerk, may be addressed.

GREENVILLE, N. C.—An electric light plant is to be established. The mayor can be addressed for further particulars.

OSHKOSH, WIS.—The matter of awarding the contract for electric lighting of the city has been laid over for three weeks.

LONG PRAIRIE, MINN.—Pedersen & Linderad, of Ettrick, Wis., will put in an electric light plant at Long Prairie, to cost $10,000.

COLUMBIA, S. C.—An electric light plant will probably be erected by the city. Information may be obtained from the mayor.

GENESEO, N. Y.—The village trustees have awarded the contract for electric lighting for the village to the Geneseo Gas Light Company.

LAWTON, MICH.—The contract for the building of the electric light plant has been let, and prices are wanted for apparatus and equipment.

WASHINGTON, PA.—The electric light company proposes to extend its lines to Houstonville, where it will light the church and business houses.

MARBLEHEAD, MASS.—It has been decided at the town meeting to leave to the electric light committee the matter of site for the proposed new plant.

WINSTED, CONN.—Fire has destroyed the large incandescent machine at the electric light works at The Falls; 75 telephone instruments were burned.

STUYVESANT FALLS, N. Y.—Mr. Frisbee proposes to make many improvements at Island Park this summer, to include electric light for the grounds.

ROCHESTER, MINN.—The Council will call for bids for enlarging the new electric light plant, to enable the city to furnish light for commercial purposes.

ST. PAUL, MINN.—Sealed proposals will be received to May 2 for electric work on the new City and County Hospital. Thos. A. Prendergast is secretary.

LEADVILLE, COL.—As the result of a decision of Judge Dickson, the Citizens' Electric Light Company will go ahead with the work of constructing its lines.

TARPON SPRINGS, FLA.—A recent fire burned out a large part of the electric lighting plant of the Florida and West Coast Company, and the plant is shut down.

OSHKOSH, WIS.—The electric light committee reports that a plant capable of lighting the city should be established for $50,000, and cost of maintaining same $16,000.

TOPEKA, KAN.—An electrical building is to be annexed to the State University, and bids are desired. The Legislature has appropriated $72,000 for the purpose.

KINGSTON, N. Y.—A representative of the Western Electric Company is in town to submit estimates to the Common Council for a municipal electric lighting plant.

HAMILTON, OHIO.—Frank B. Rae, electrical engineer, 27 Cleland Building, Detroit, Mich., is to prepare plans and specifi- for waterworks and electric light plant.

BELLEVUE, KY.—The three electric light companies have consolidated. The new company will extend the lights on Fairfield avenue, and will soon make other extensions.

OSHKOSH, WIS.—Bids will be received to May 7 for lighting the city by electricity, as per specifications on file at the Board of Public Works, of which H. Stopper is chairman.

HACKETTSTOWN, N. J.—The lamp committee has been instructed to call for bids for lighting the streets of the city during the coming year with 85 or more electric lights.

PARIS, KY.—The Paris Electric Light Company is adding new machinery, including a 150-h. p. engine and boiler, a 50-light arc dynamo and a 2,700-light incandescent dynamo.

ELLSWORTH, ME.—The electric light company at Ellsworth asks for an increase for the coming year, or they will not run the plant. The town authorities are not likely to comply.

PHILADELPHIA, PA.—An electric light plant is wanted for the new morgue on Wood street, including a dynamo and gas engine. Chief Elsehover, of the Bureau of City Property, may be addressed.

ENFIELD, CONN.—Henry C. Douglas, of Windsor Locks, has sold his property at Terry's Island to Hon. E. B. Bailey, of Windsor Locks. Mr. Bailey will give all details of the proposed dam and electric power plant.

MONTROSE, PA.—It is stated that the Consumers' Water Company will, in the near future, put in an electric light plant, and will purchase another boiler and engine for the pumping station.

JERSEY CITY, N. J.—The Hudson County Board of Freeholders has awarded the contract for the electric light plant at Snake Hill to the Complete Electric Construction Company at $93,232.20.

FREEPORT, ILL.—The Freeport "Democrat" states that the electric light plant will be purchased by the new owners of the street railway company, and that the road will be operated by electricity in July.

NEW BEDFORD, MASS.—Alderman I. L. Ashley, chairman City Council committee on street lights, states, as the result of his investigations, that New Bedford can operate a plant at about two-thirds the cost of the present system.

ANN ARBOR, MICH.—The committee on building and grounds of the State University reports in favor of advertising for bids for the erection and equipment of a central heating and electric lighting plant for the buildings on the campus.

SOUTH BETHLEHEM, PA.—Sealed proposals will be received to May 7 for lighting the streets of the borough of South Bethlehem for a period of five years with electric arc lights of 2,000 c. p. Frank Gorman is chairman of the lamp committee.

SACRAMENTO, CAL.—The entire electric plant of the Capitol Gas Company, which holds contracts for lighting the city and running street cars, has been burned, and 24 dynamos were destroyed. The plant was one of the largest on the coast, and cost $300,000.

WAUKEGAN, ILL., wants bids for street lighting, including 80 arc lamps of 2,000 c. p., burned on the Philadelphia moonlight schedule, to 12 o'clock, to 2 o'clock or all night, for terms of three or five years. Bids will be opened May 14. Henry Thacker is city clerk.

BELAIR, MD.—The Henry Reckford Manufacturing Company, of Belair, Md., proposes to run the machinery in its flouring mill by electricity instead of steam, and is negotiating with the town authorities in the matter of furnishing electric light for the town of Belair.

WASHINGTON, D. C.—A bill to incorporate the National Gas and Electric Light and Heat Company has been introduced in the House by Mr. Campbell. The incorporators are J. Wesley Bovee, John W. Childers, John F. Chamberlain, Davies Murdoch and Chas. C. Lancaster. The capital is $2,000,000.

NEWBERRY, MICH.—Sealed proposals will be received to June 2 for the erection of a power house, electric light and pumping plant at the Upper Peninsular Asylum; Claude W. Chase is chairman of the building committee. Charlton & Gilbert, architects, Marquette, Mich., will give details.

COVINGTON, KY.—The consolidation of the Covington Electric Light Company, Citizens' Electric Light Company, of Dayton, and the Suburban Illuminating, Heating and Power Company, of Newport, has been consummated, and the name adopted is the Subur-

ban Electric Company. The capital is $250,000, and J. E. Lowes, of Dayton, Ohio, is the president.

The Electric Railway.

DEERING, ME.—The Portland Electric Street Railway Company is to build a new power house.

WINDSOR, CONN.—Selectman J. E. Higinbotham states that the proposed electric road is now a certainty.

CORTLAND, N. Y.—Final action on the franchise for the electric street railway has been postponed to May 1.

YORK, PA.—The York Street Railway Company is asking for bids for the extension of its lines, the work to begin immediately.

ST. JAMES, MINN.—The village will vote April 30 in the matter of issuing bonds for waterworks and electric lights.

BRADFORD, PA.—The ordinance to grant a franchise to the Bradford and Kendall Railway has been laid on the table.

RICHMOND, VA.—The Virginia Electric and Railway Company has petitioned the City Council for permission to construct a viaduct.

MEMPHIS, TENN.—The Citizens' Railway has consolidated the East End dummy line with its lines, and has it now electrically equipped.

FREDERICK, MD.—A company has been organized to build the Frederick and Middletown electric road. D. E. Kefauver is secretary.

WASHINGTON, D. C.—The Metropolitan Street Railroad Company wants, and has not yet contracted for, an underground electrical equipment.

HIGHLAND, N. Y.—Superintendent W. Price informs the "Republic" that the New Paltz and Highland Electric Railway will surely be built this summer.

MIDDLETOWN, CONN.—The Common Council has decided to grant the petition of the Middletown Horse Railroad Company to equip the road with electricity.

CALAIS, ME.—The electric railway company will start the building of a road from St. Stephens, N. B., to Calais. Amos S. Gerald, Waterville, Me., is the manager.

POTTSVILLE, PA.—The Schuylkill Electric Railway Company proposes to issue $55,000 in bonds for improvements during the coming summer, to include motors, cars and new rails.

VERMILLION, OHIO.—An electric railway will be built from Wellington, Ohio, via Oberlin to Vermillion, and is estimated to cost $200,000. The distance is 24½ miles. Dr. R. F. Quigley can be addressed.

NORWALK, CONN.—Officers of the Norwalk Tramway Company have voted that new stock be issued to the amount of $60,000 to meet the expenses of the Roton Point extension. The company expects to have the road completed about May 30.

AMSTERDAM, N. Y.—President Clement, of the Amsterdam Electric Railway, is conferring with Hon. David A. Wells, of Johnstown, and Lawrence Caten, of Gloversville, regarding the proposed electric road from Amsterdam to Gloversville.

NIAGARA FALLS, N. Y.—E. B. Osler, of Toronto, Ont., and William Hendrie, of Hamilton, Ont., president and vice president of the Niagara Falls and Park Railway, are in Niagara Falls, Ont., looking over the ground for proposed extension to Chippewa.

LYONS, N. Y.—A special to the Buffalo "News" states that Lyons is to have an electric railroad. The power house will be located in the northern part of the village. Orlando F. Thomas, president of the Manhattan Silver Plating Company, is the prime mover in the enterprise.

EAST WEYMOUTH, MASS.—Thirteen thousand dollars of the $20,000 required for the proposed electric connection of East Weymouth with Quincy and Boston has been subscribed, and President John R. Graham, of the Quincy and Boston Railway, states that the road will surely be built.

WASHINGTON, D. C.—The petition of the National Rapid Transit Company for a franchise for an elevated electric road from Washington to New York, as promoted by Mr. Hemphill, ex-Chairman of the District of Columbia Committee of the House of Representatives, has been referred to a sub-committee.

CHICOPEE, MASS.—An electric railway company, with $100,000 capital, has been formed to build a line from Holyoke through Willimansett to Chicopee, thence to terminate at Springfield. It will be called the Chicopee Street Railway Company, and will be about 10 miles long. The directors are Charles C. Abbey, ex-Senator Gibson and James H. Loomis, of Chicopee; William Kickham, of Worcester; J. E. Delaney, of Holyoke, and Selig Manilla, of Springfield.

Miscellaneous Notes.

THE MAGNETIC CLUB DINNER at Jaeger's, corner 59th street and Madison avenue, New York, on Tuesday evening, April 24, was one of the most largely attended meetings ever held by the club. The special guest of the evening was Mr. Charles Selden, of Baltimore, president of the Old Time Telegraphers' Association. The Postal Telegraph Company was represented at the dinner by more than a dozen of its officers and principal employes, who occupied a table by themselves. President Cockey, of the Magnetic Club, good naturedly suggested that this was the way the company chose to announce to the members that its new building was completed, just as young ladies have been known to attend church apparently to show off new dresses. The Magnetic Club is in a prosperous condition, and every one present at the dinner evidently enjoyed the occasion and the hearty and spontaneous sociability

Personal Notes.

MR. BIRDSALL HOLLY died at his home, at Lockport, N. Y., on Thursday, April 27. Mr. Holly was an engineer by profession. He devised a new waterworks system, and was the inventor of the well known Holly system of district steam heating.

A CORRECTION.—By one of those unfortunate mistakes, which occur in every well regulated printing office, in the biographical sketches of the officers of the Pettingell-Andrews Company, it was stated that Mr. Frank X. Cicott occupied the position of secretary and general manager of the company. It was intended that this clause should be inserted in the sketch of Mr. C. B. Price, the actual occupant of that position, but unfortunately an error was made. Mr. Cicott, as is well known, is manager of the railway department.

MR. G. H. BUCKMINSTER, purchasing agent for the Pettingell-Andrews Company, of Boston, was born in Nashua, N. H., but his boyhood days were mostly spent in East Boston, where he was given an excellent grammar school education. His entire business life has been confined to the electrical supply business, in which he has had an experience of over eight years, and with which he is thoroughly familiar. At the age of 16 he entered the employ of the Electric Gas Lighting Company, of Boston, remaining with it for four years, and becoming, through ability and faithfulness, one of its principal salesmen, Leaving this company, he identified himself with the Eastern Electric Supply Company, of Boston, as purchasing agent and chief salesman, which position he held until the company went out of business, in August, 1892. He then connected himself immediately with the Pettingell-Andrews Company, and with the reorganization of the company, in 1893, was made its purchasing agent, which position he fills with profit to the company and credit to himself. Mr. Buckminster is a worthy representative of the younger element so conspicuously identified with the electrical business generally.

Trade and Industrial Notes

THE STANDARD PAINT COMPANY, 2 Liberty street, New York, reports increased demand for its P. & B. insulating compound.

THE HARRISON INTERNATIONAL TELEPHONE CONSTRUCTION COMPANY, 44-46 Wall street, New York, has recently decided to sell, as well as lease, its telephones.

THE NEW YORK STATE ELECTRICAL COMPANY, of Canisteo, N. Y., has purchased the plant of the Malleable Iron Company at Youngstown, Ohio, and will manufacture electrical supplies.

HARRY S. SMITH & CO., 607 Chestnut street, Philadelphia, have issued a handsome catalogue, describing the different forms of fans and fan motors sold by them, which are illustrated in great variety. The motors are for direct and alternating circuits, and furnished as required for the different voltages in use.

W. R. FLEMING & CO., 203 Broadway, New York, and 620 Atlantic avenue, Boston, the New York and New England representatives of the Harrisburg Foundry and Machine Works, have sold between 30 and 40 of the Harrisburg Ideal direct connected engines and dynamos in their territory.

THE PECKHAM MOTOR TRUCK AND WHEEL COMPANY, Havemeyer Building, New York City, has in use over 1,500 trucks in New York, Brooklyn and Jersey City. Orders are constantly being received from all parts of the country, which necessitates the operation of the works at Kingston, N. Y., both day and night.

THE AMERICAN DISTRICT STEAM COMPANY, Lockport, N. Y., has contracted with the Economy Heat, Light and Power Company, of Scranton, Pa., for the construction of a steam heating and power plant, with underground mains (Holly system), to cost $150,000. The officers of that company are Wm. Connell, president; Lemuel Amerman, vice president; Lieut.-Gov. Watres, treasurer, and I. H. Burns, secretary.

THE CENTRAL ELECTRIC HEATING COMPANY, 26-28 Cortlandt street, New York, is busily engaged equipping cars through-

out the country with its electric heater, which is fast superseding the old and inconvenient way of heating cars by stoves. Street railway companies generally are taking time by the forelock and are having their new cars wired, during construction, preparatory to placing electric heaters in them.

MR. C. J. MILLER, well known in electrical circles in Philadelphia as the former superintendent of the Novelty Electric Works, the inventor of the Novelty wire gauge and other electric specialties, which take so well among wire men, has opened an office, store and works of his own at No. 4½ North Fifth street. Mr. Miller expects to handle a full line of standard electric materials, and do electrical engineering and special experimental and model work.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., has designed and built the roofs for the new electric light and power station for the Brush Electric Light Company, at Baltimore, Md., which will be one of the finest in the Southern States. The boiler room is 83 feet wide by 129 feet long. The dynamo room is 130 feet square, the floor space being entirely free from posts. The roofs are made entirely of iron, covered with anti-condensation corrugated iron roof covering.

THE CLARK ELECTRIC COMPANY, 192 Broadway, New York, has recently brought out an arc lamp, which, it is said, runs very successfully upon the Heisler system. It has been supposed that this was one of the most difficult things to accomplish, for the reason that the Heisler is a series incandescent system, the current being only five amperes. The Clark company claims that it is the only concern that makes arc lamps which can be used upon any and every known system, and asserts that it has never put out an apparatus which has not given entire satisfaction to the purchaser.

KENNEDY AND DU PEROW is the firm name of an electrical supply house recently established at No. 1421 F street, N. W., Washington, D. C., and is the only purely electrical supply house in that city, all other electrical firms combining construction with supply business. Mr. Kennedy was formerly with the Royce & Marean Electrical Company for many years, filling the position of buyer, and Mr. Du Perow was connected with the Postal Telegraph Company, occupying the position of electrician for many years, and has also been manager of the District Telegraph Company, of Washington.

THE HARRISON SAFETY BOILER WORKS, Germantown Junction, Philadelphia, also manufactures the Cochrane feed-water heaters, and have issued a 40-page catalogue, illustrating and describing the various forms of these apparatus. Besides the usual form of feed-water heaters, there are manufactured combined feed water heaters and purifiers, and special feed water heaters and receivers, the latter for use where the exhaust is employed for heating purposes. Much information of general technical value will be found in the pamphlet, while the sectional views of apparatus show very clearly their construction and operation.

THE INSTITUTE FOR HOME STUDY OF ELECTRICITY, of Cleveland, Ohio, of which the Scientific Machinist Company is the proprietor, and Messrs. N. S. Amstutz and John C. Lincoln are the directors, has recently enrolled several students from foreign countries, and is sending its catalogue to almost every civilized land. Since its inception, in 1893, a large amount of money has been spent in preparing and improving its facilities for making its instruction thorough and effective. The proprietors will soon make an announcement that will be of interest to every one engaged in electrical or mechanical work, or who is contemplating taking up the study of electricity.

THE VULCANIZED FIBRE COMPANY, of Wilmington, Del., has issued a 40-page catalogue, giving information relating to vulcanized fibre and the great variety of uses to which it is applied. We learn that this material, which now has been on the market for over 20 years, is made by treating specially prepared vegetable fibre with powerful chemical agents, whereby the exterior portion of each separate fibre becomes glutinous, and while in this condition the whole mass is consolidated under very heavy pressure and becomes practically homogeneous, after which the chemicals are extracted. Two varieties are manufactured: hard fibre, which closely resembles horn, and flexible fibre, which has the appearance of closely grained sole leather. For electrical insulation the hard fibre is used and applied to almost every conceivable purpose where good insulation is a necessity.

HUGO REISINGER, 38 Beaver street, New York, importer of the celebrated "Electra" high grade Nuernberg carbons, which received a premium at the Chicago World's Fair, calls attention to the following paragraph in an article by Prof. H. S. Carhart, that appeared in The Electrical World: "The days of cheap and inefficient carbons should soon be passed, for wherever a highly efficient service is desired, instead of merely a cheap one, it is of the utmost importance to use the best carbons obtainable." The tendency of the trade seems to be for the more general adoption of low tension direct and alternating current arc lamps, for which a high grade carbon is required in order to obtain highly efficient service, and leading electric lighting stations of this country, who have adopted the "Electra" carbons exclusively for their arc lighting, speak in the highest terms of their superior quality and efficiency.

THE E. S. GREELEY & CO., 5 and 7 Dey street, New York, have found it necessary to acquire more space to better facilitate the handling of their enormous business. The Postal Telegraph Company, which is now installed in its new building, Broadway and Murray street, formerly occupied the floors immediately over the warerooms of the E. S. Greeley & Co. Since the leave-taking of the Postal company, the Greeley corporation have leased the entire buildings known as 5 and 7 Dey street, consisting of five floors and basement, 55 by 90 feet. An electric elevator of their own manufacture has been installed, the better to handle heavy and cumbersome articles. The basement, as heretofore, will be used chiefly for storage purposes, the ground or street floor as warerooms, while the four remaining floors will be devoted to the manufacture of light electrical apparatus; and here also will be carried on the experimental work for which this house is justly celebrated.

MR. C. M. GIDDINGS, who has been for the past six years in charge of the Sioux City Engine Works, has recently connected himself with The Brownell & Co., of Dayton, Ohio, the well known manufacturers of boilers and engines, who have bought the exclusive right to manufacture under his patents, and have established a department of engineering, with Mr. Giddings as superintendent. The Brownell & Co. will make a specialty of high grade automatic engines, both simple and compound, and have purchased the entire stock of drawings, patterns, finished and unfinished automatic engines of the Sioux City Engine Works. These engines are well known in the trade as the Russell single valve automatic. Mr. Giddings was in charge of the engineering department of the Sioux City Engine Works for four of the seven years he was with them, and while there designed and patented his well known governor and valve. The Brownell & Co. have recently added to their boiler shop equipment a set of 20-foot rolls 18 inches in diameter, capable of rolling the heaviest plate, and making 20-foot boilers in two sheets. This, with the special machinery of their own design and make, puts them at the head of well equipped boiler manufacturers.

THE DEWEY ELECTRIC SIGNAL COMPANY was last week incorporated under the laws of the State of New Jersey, the following named gentlemen being the incorporators: Messrs. Arthur M. Dodge, J. F. Tams F. G. Ingersoll, Edw. B. Wyman and Geo. B. Hollister. As the name implies, the object of the company is to introduce an electrical system of signal bells and alarm gongs for use on cars propelled by electricity. The system consists of a signal bell at each end of the car, under the hood, and an alarm gong on the roof of the car, both of which are operated by current taken from the main line or trolley. The signal bells, used by the conductor for signaling the motorman to start or stop the car, are operated by simple push buttons, conveniently located at different intervals throughout the inside of the car, and under the hood at each end. This system avoids the unsightly strap or cord, which is usually employed to operate the signals, and enables the conductor to communicate easily and instantly with the motorman. In the alarm gongs a great many advantages exist over the present method. One gong only is necessary (one or more may be used, if desired), and is operated by the motorman by the simple pressure of his foot on a push button, and the gong will continue ringing loudly until the foot is removed, thus doing away with the continual movement of the foot up and down, and enabling him to devote his entire attention to the controller and brake. At critical times, when quick action is necessary on the part of the motorman, he has only two things to think of, where this system is employed—that of using one hand to operate the controller and the other to operate the brake. The importance to railway companies and the public of this feature of the system cannot be overestimated, and it enables inexperienced men to become competent motormen in half the time usually required. The amount of current necessary to operate the signals and gong is scarcely noticeable, and they are entirely independent of the conditions of the motor circuit. The headquarters of the Dewey Electric Signal Company are in the Havemeyer Building, Cortlandt, corner of Church streets, New York.

Business Notices.

FOR ADVERTISEMENT of the celebrated Law Battery Company, of 85 John street, New York, see page xi.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

MR. C. J. MILLER, a reputable electrical man of Philadelphia, has opened an office and store at No. 4½ North Fifth street, where he will be pleased to represent parties with any reliable electrical materials.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient, and at prices lower than ever. THE HAYDEN-BOOKER MF'G. CO., 2140 DeKalb St., St. Louis, Mo.

THE ALLGEMEINE ELEKTRICITAETS-GESELLSCHAFT, Berlin, Germany, announce herewith that, owing to the general appreciation which their exhibition has met at the World's Fair, it is their intention to appoint selling agents in New York, Chicago, Cincinnati, Atlanta, San Francisco, Boston, Philadelphia, St. Paul, Washington, Denver, etc., for the sale of their manufacture. Trustworthy electrical firms inclined to handle their goods are requested to forward offers to the head offices, 22 Schiffbauerdamm, N. W. Berlin.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED APRIL 17, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

518,213. INSULATING TURNBUCKLE; H. P. Ball, Schenectady, N. Y. Application filed Dec. 22, 1893. This comprises a central shank, a cup adapted to rotate about such shank, insulating material interposed between the two, an eye bolt threaded into the shank and an eye plate secured to the cup.

518,214. CEILING CLEAT; H. P. Ball, Bridgeport, Conn. Application filed Jan. 12, 1894. This comprises a body portion and lugs forming diagonal channels upon the end of the cleat, adapted to hold a wire in place.

518,217. MEANS FOR EXCITING FIELD MAGNETS OF ALTERNATING CURRENT DYNAMOS; L. Bell, Boston, Mass. Application filed Nov. 17, 1893. The combination of dynamos having their field magnet coils connected in a common circuit and motor generators actuated by alternating current and delivering continuous current to the circuit.

518,218. REGULATOR FOR DYNAMO ELECTRIC MACHINES; L. Bell, Boston, Mass. Application filed Nov. 28, 1893. This comprises an ampere meter having a movable scale, a rheostat and means whereby the movement of the rheostat arm actuates the scale of the ampere meter. (See illustration.)

518,221. ELECTRIC MOTOR CAR; H. P. Brown, New York, N. Y. Application filed Dec. 21, 1891. This comprises a reducing gear with pinions and sleeve pinions, in combination with an internal gear, and a spider made in a separate piece from the internal gear.

518,231. ELECTRIC SWITCH; A. Ekstrom, Lynn, Mass. Application filed Dec. 24, 1890. This comprises a closed box, two sets of terminals therein, a cam within the box, and a supplementary spring.

518,232. REGULATOR FOR DYNAMO ELECTRIC MACHINES; W. H. Elkins, Cambridge, Mass. Application filed Jan. 3, 1893. This comprises shifting commutator brushes, a motor magnet, with a controlling magnet and two or more sets of contacts controlled by the controlling magnet.

518,236. RHEOSTAT; J. P. B. Fiske, Lynn,, Mass. Application filed Feb. 25, 1893. This comprises a frame and a tier of removable trays supported therein, each tray containing a resistance coil.

518,244. CUT-OUT METER; C. D. Hopkins, Lynn, Mass. Application filed Sept. 19, 1892. This comprises a meter and a switch held closed by a detent, but adapted to be released by the closing of an electric circuit by the meter.

518,245. DAMPING DEVICE FOR ELECTRICAL MEASURING INSTRUMENTS; F. Holden, Lynn, Mass. Application filed March 3, 1893. This consists of a hermetically sealed chamber, having a plain inner surface and inclosing a viscous liquid.

518,254. CONTROLLER FOR ELECTRIC RAILWAY CARS; W. H. Knight, Lynn, Mass. Application filed Dec. 21, 1893. A controller actuated from a source of fluid pressure carried on the car, and an indicator adapted to show the position of the controller.

518,263. TELEPHONIC APPARATUS; C. Milde, Paris, France. Application filed Oct. 31, 1893. This consists of a corrugated box partly filled with granulated coke, the box having a carbon stud extending through it at each side and carrying a weight, one of the studs being connected to the vibrating transmission plate.

518,265. ELECTRIC MEASURING INSTRUMENT FOR MULTIPHASE SYSTEMS; E. W. Mix, Lynn, Mass. Application filed March 21, 1892. An instrument having relatively movable field and armature sets of coils connected in circuit with an inshunt across the several lines, and arranged to produce two non-coincident polarities revolving in the same direction.

518,290. ARMATURE FOR DYNAMO ELECTRIC MACHINES; E. Thomson, Swampscott, Mass. Application filed Jan. 19, 1892. An armature shaft having a hub secured thereto with flat faces tapering in a direction parallel to the shaft, in combination with a two part spider shaped to fit the hub, and thereby attached to the shaft.

518,291. MODE OF COOLING ELECTRIC MOTORS; E. Thomson, Swampscott, Mass. Application filed Nov. 30, 1892. The combination of an electric motor, a closed casing therefor, provided with projecting studs or lugs adapted to increase its radiating surface, a pipe communicating with such casing, and a water jacket surrounding a portion of the pipe, all arranged to provide a waterproof inclosing casing adapted to dissipate the heat generated therein.

518,293. ELECTRIC RAILWAY SYSTEM; C. D. Tisdale, Boston, Mass. Application filed April 26, 1893. This consists of a car truck having insulated wheels, furnished with auxiliary wheels for taking the current from one conductor and returning it to the other conductor.

518,301. CEILING CLEAT; H. C. Wirt, Boston, Mass. Application filed Oct. 27, 1893. This consists of a block having at one end a wedge-shaped convex bearing, and at the other end a similar concave bearing.

518,310. UNIVERSAL PHASE ALTERNATE CURRENT MOTOR; T. Duncan, Fort Wayne, Ind. Application filed May 22, 1893. The combination of field magnet, armature, bearing heads, diverter, lever, worm gear, adjusting shaft and a plug or switchboard. (See illustration.)

518,311. ELECTRIC METER; T. Duncan, Fort Wayne, Ind. Application filed Aug. 2, 1893. The combination of a motor driven by the energy to be measured, and a compound drag or brake armature revoluble with the motor spindle and within a constant field of force established by theoretically adjustable magnets.

518,312. ARMATURE; E. Egger and F. A. Wessel, New York, N. Y. Application filed May 17, 1893. The combination of a core having grooves, insulated iron plates fitting in the grooves, and conductors wound between the plates and on the core.

518,331. TELEPHONE EXCHANGE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed Jan. 19, 1894. This comprises an individual annunciator and battery at central station in a bridge of a metallic circuit, a normally open telephone circuit at the subscriber's station, means for closing the telephone circuit, and means for cutting out the annunciator and battery.

518,332. TELEPHONE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed Nov. 14, 1893. In a trunk line, the combination with a condenser in one limb thereof, of a battery and an indicator in a bridge between the two limbs of the trunk line, and means for connecting the bridge upon either side of the condenser.

518,333. TELEPHONE EXCHANGE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed March 3, 1893. This consists of a subscriber's metallic circuit normally open at the subscriber's station, a normal connection to ground one limb of the circuit at the central station, containing a calling device, and means whereby the subscriber may close the circuit to include himself directly in circuit with the operator.

518,334. TELEPHONE EXCHANGE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. Application filed April 13, 1893. This comprises a metallic circuit, a pair of contact anvils, and a switch at the subscriber's station.

518,337. ELECTRIC TOWER CLOCK; C. D. Warner, Ansonia, Conn. Application filed April 6, 1893. This comprises a motor and a circuit therefor, and mechanism for opening the circuit and permitting the motor to run by acquired momentum.

518,345. CONTROLLER FOR ELECTRIC MOTORS; W. Cooper, Minneapolis, Minn. Application filed Aug. 28, 1893. This comprises resistance sections arranged in two groups with a gap between the same, a contact brush to sweep over the sections, a four point switch, and means in connection with the arm for operating the switch as the brush passes over the gap.

518,349. REGULATOR FOR DYNAMO ELECTRIC MACHINES; C. L. F. Muller, Milwaukee, Wis. Application filed May 13, 1889. This consists in dividing the several armature coils into sections and of providing a device whereby the sections of each coil or each pair of coils may be combined in series, multiple arc or groups for producing currents of different degrees of quantity or intensity.

518,357. AUTOMATIC TROLLEY WIRE FINDER; T. Straus, Baltimore, Md. Application filed Jan. 26, 1894. A trolley arm bent upwardly near its outer end, of a spring projected sliding extension, a trolley wheel and inclined guides pivotally mounted in the extension, the guides being automatically operated by the pressure of the trolley upon the wire.

518,359. ELECTRIC CURRENT REGULATOR; A. G. Waterhouse, Hartford, Conn. Application filed Nov. 26, 1892. The combination with a branched electric circuit, of an electrolytic cell or cells having non-attackable electrodes in a branch, and a current generator, this current generator and the electrolytic cell being in series with one another on the local circuit formed by the branches.

518,360. METHOD OF REGULATING ELECTRIC CURRENTS; A. G. Waterhouse, Hartford, Conn. Application filed April 13, 1894. The combination with a main circuit, the current in which is to be maintained below a fixed limit, of a regulating shunt circuit, including an electrolytic pile having non-attackable electrodes, and a resistance.

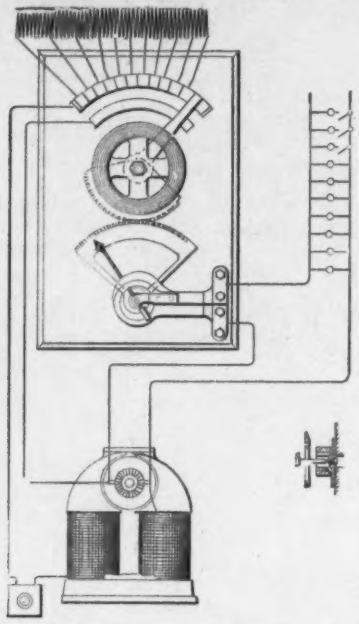
518,362. TROLLEY WHEEL; J. D. Ansley, Cambridge, Mass. Application filed July 27, 1893. This consists of a bushing of pure copper for trolley wheels and loose pulleys.

518,365. RHEOSTAT; A. C. Dinkey, Allegheny County, Pa. Application filed Dec. 1, 1893. A rheostat having a cylinder provided with a projecting piston rod, and a pipe leading from the cylinder.

518,367. MULTIPLEX TELEPHONY; W. W. Jacques, Newton, Mass. Application filed Nov. 22, 1893. A telephone circuit, grounded or metallic, and two telephones or telephone sets at each end of the telephone circuit, two vibrating switches, one also at each end of the circuit adapted to connect and disconnect therewith each of the telephones or telephone sets at the same end at every vibration, and mechanism for vibrating the switches synchronously and with rapidity.

518,392. TELEPHONE TRANSMITTER FROM SECONDARY BATTERIES; J. J. Carty, New York, N. Y. Application filed April 14, 1891. The combination with a storage battery or secondary battery of low internal resistance, of telephone transmitters connected in parallel between its poles, and deriving current therefrom.

518,404. ELECTRIC STARTING SWITCH; F. V. Henshaw, Brooklyn, N. Y. Application filed June 2, 1893. The combination with an electric motor and with main line conductors, of circuit closers closed between both conductors, and the motor, and variable resistance between one conductor and the motor, and



NO. 518,218.—REGULATOR FOR DYNAMO ELECTRIC MACHINES.

in series with the field magnet, and having terminals in the path of the last named circuit closer, and means for short-circuiting the resistances with respect to the field magnet.

518,414. BOND FOR ELECTRIC RAILWAYS; J. Meyer, New York, N. Y. Application filed Jan. 18, 1894. In electric railways, the combination, with conductors, of a bond or bonds connecting same, a container, means for attaching the container to the conductors, the container being provided with outwardly bulging side portions, and insulating material in the container.

518,444. DYNAMO ELECTRIC MACHINE; H. E. Dikeman, Berkeley, Cal. Application filed Feb. 13, 1894. In a dynamo electric machine, the combination of a base, sliding standards thereon, means for adjusting the standards to and from each other, a shaft journaled in the standards and carrying an armature, and the separable field magnets also journaled upon the standards in independent bearings.

518,471. ELECTRIC SWITCH; J. B. Smith, Manchester, N. H. Application filed Oct. 10, 1893. In a circuit for electrical distribution, the combination of one or a pair of switch levers located in the circuit, a magnetic field energized by the circuit and having two opposed windings, one arranged as a shunt to the circuit, and the other in series with it, a movable armature acting to hold the switch closed when the electrical pressure in the circuit equals a predetermined amount, and to open the switch and break the circuit in each wire of the main line when the electrical pressure falls below a certain amount, or when the current in the circuit increases above a certain amount.

518,481. ELECTRICAL CONTACT MECHANISM; J. F. Blake, New Haven, Conn. Application filed Feb. 23, 1894. A base or support and a pressure actuated spring mounted thereupon, a circuit closer composed of two carbons, one carried by the base or support, and the other carried by one end portion of the spring, an electromagnet and resistances in the circuit of the circuit closer, an armature actuated by the electromagnet, and a secondary circuit closer composed of two carbons, one carried by the base and the other carried by the armature.

518,511. ELECTRIC RAILWAY SIGNAL; B. F. Rex, St. Louis, Mo. Application filed March 4, 1892. In combination with a trolley, a housing supporting and inclosing the same, and brushes pivoted to the lower outside edges of the housing.

518,525. AUTOMATIC ELECTRIC SIGNALING DEVICE FOR CROSSINGS; E. A. Hermann, St. Louis, Mo. Application filed ——— —. In an automatic signaling device, an electromagnet mounted in a box or inclosure constructed to be connected to a pole, a semaphore or arm having a bracket connected to one end, carried by the armature shaft to the electromagnet, detachable stops or rings connected to the front side of the inclosure for limiting the movement of the arm or semaphore, and electrical conductors leading to and from the electromagnets for energizing the armature for operating the semaphore or arm.

518,534. ELECTRIC CURRENT RECORDER; J. W. Th. Olan, New York, N. Y. Application filed July 7, 1892. In an electric current recorder the combination of a vibrating arm or pointer, a coil or magnet for moving it along, a record sheet moved by time mechanism, an armature carried by the vibrating free end of the arm or pointer, an electromagnet for moving the armature and means carried by the arm or pointer to mark the sheet.

518,540. ELECTRIC RAILWAY CONDUIT; P. P. Banholzer, Philadelphia, Pa. Application filed Nov. 16, 1893. A conductor for underground systems composed of a plate having a series of prongs on one face to anchor the plate in a plastic material.

518,542. THERMO-ELECTRIC GENERATOR; H. B. Cox, Hartford, Conn. Application filed April 28, 1892. A thermo-electric pile having the closely fitted metallic jacket forming its outer surface.

518,543. METHOD OF APPARATUS FOR AMALGAMATING ORES; H. F. Edwards, Butte, Mont. Application filed March 17, 1893. An electrolytic tank provided with electrodes secured to the sides thereof and insulated from the bottom of the tank, in combination with agitators adapted to move close to the bottom of the tank to agitate the mercury, which is adapted to be placed in this tank.

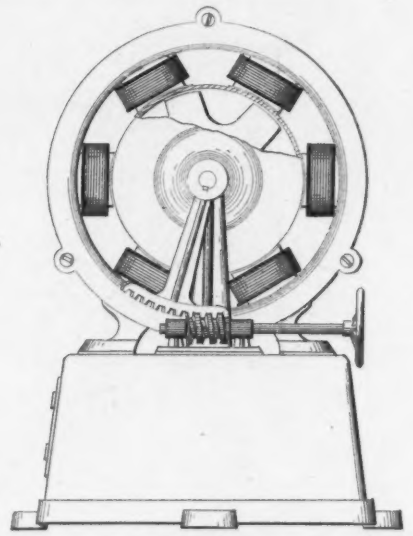
518,561. ELECTRIC MOTOR; H. P. Brown, New York, N. Y. Application filed Jan. 26, 1893. In an electric machine or motor, a pivoted brush holder furnished with a hollow counterbalance arm adapted to receive a counterbalance weight.

518,562. ARMATURE FOR ELECTRIC MOTORS; H. P. Brown, New York, N. Y. Application filed Feb. 6, 1893. A commutator furnished with segments and mica strips between the segments and provided with a hollow ring or space between the shaft and the segments containing burned shellac.

EXPIRED APRIL 3, 1894.

189,116. DYNAMO ELECTRIC MACHINE; D. F. J. Lontin, Paris, France. Filed March 1, 1876. This comprises a set of movable induced magnets, a stationary induced magnet having its core extended and provided with one or more separate coils, from which alternate currents in opposite directions may be taken.

189,184. AUTOMATIC TELEGRAPHY; J. W. Brown, Port Huron, Mich. Filed May 21, 1875. The combination of a perforated strip, marking, compensating and reversing pens, battery and resistance, and circuit connections whereby a dash is transmitted by using first a strong initial current, second the compensation therefor, third a current similar to the initial current, and lastly a reversing current.



NO. 518,310.—UNIVERSAL PHASE ALTERNATING CURRENT MOTOR.

189,276. MULTIPLE TELEGRAPHS; G. Smith, Astoria, N. Y. Filed Feb. 10, 1877. A receiving instrument having one armature so arranged as to respond to changes in the strength and in the polarity of the line current, either or both, in combination with two independent sounding or recording instruments.

EXPIRED APRIL 10, 1894.

189,391. ELECTRO-PNEUMATIC MUSIC PLAYING APPARATUS; W. F. Schmoele and H. Schmoele, Jr., Philadelphia, Pa. Filed Feb. 25, 1874. The combination of an electromagnet and armature with an internal pocket or train of pockets.

189,533. PROCESS AND APPARATUS FOR ELECTRO-PLATING WIRE; W. Wallace, Ansonia, Conn., and L. L. Smith, Passaic, N. J. Filed Feb. 5, 1877. This consists in distributing the convolutions forming the coil in substantially an axial line with each other and then subjecting them to the action of the coating bath during their gradual rotation.

EXPIRED APRIL 17, 1894.

189,779. GALVANIC BATTERIES; M. W. Parrish, Jackson, Mich. Filed Jan. 11, 1877. The combination with the jar of a galvanic battery, and with the positive element contained therein, of a negative element made in two sections.

Copies of the specifications anddrawings complete of any patent mentioned in this record---or of any other patent issued since 1886---can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, New York.